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Relationships between a Cognitive Testing Instrument, Academic Points Scores and Average Academic Results of National Diploma Students at a University of Technology

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Dissertation presented in partial fulfilment of the requirements for MA Research Psychology, Department of Psychology, School of Human and Community Development

I declare this project is my own work and has not been submitted before for any other degree or examination at this or any other University. Contributions from other works have been referenced and acknowledged as such.



Signature

24 June 2014

Date

Acknowledgements

To my supervisor, Mike Greyling, for his hard work, long hours and insistence on quality. I appreciate all you have done and all you have taught me (and encouraged me to learn for myself) throughout this process. Thank you for putting up with my ‘slow’ moments and pointing me in the right direction.

To my mother, Lesley, for listening to my rants, encouraging me when I wanted to give up and celebrating my small successes.

To my father, Piet and his wife, Jenna, for reminding me to do one thing at a time, proof reading pages which made absolutely no sense, their encouragement and their reminders of the good things to come.

To Saffiya, Leanie and Caroline, my work colleagues, for picking up the slack I let out during this project.

Lastly, to all my horses, dog (Kian) and cat (Krissy) (who sadly can’t read) for keeping me sane.

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Chapter 1: Introduction and Aim

In 2009, approximately 521,430 students were enrolled in public Higher Education institutions as full time or contact students (Department of Basic Education, 2010). This number is merely a small proportion of the number of applications received, many of which are turned away due to limited availability of places within institutions. The same year saw 144,852 graduates with a formal undergraduate or post-graduate qualification. However, a deeper analysis of the data by the Department of Basic Education (2010) revealed that an average of only 16% of students who enrol for their first year of an Undergraduate Degree or Diploma will be successful and graduate with their qualification. Approximately 30% of students drop out in their first year of study for various reasons, and a further 20% in their second and third years of study, meaning that approximately 50% of students leave institutions before even reaching the three year threshold for graduation (Letseka & Malle, 2008). High drop-out rates combined with low success rates within the stipulated three year period have serious implications for the Institutions and the South African government. It is estimated that approximately R4.5 billion in subsidies, grants and other financial assistance to tertiary education students was squandered between the years 2000 and 2004 with little or no return on the initial investment. In addition, Letseka and Malle (2008) as part of a report for the Human Sciences Research Council, provide evidence that approximately 70% of tertiary education students come from 'low socio-economic status' making them reliant on the National Student Financial Aid Scheme (NSFAS) to provide them with study loans and other financial assistance, the majority of which is not repaid, putting further strain on the country's economic resources.

South African tertiary education is therefore faced with a complex problem – how does one increase throughput (graduation) rates, thereby increasing the chances of return on financial investments while enhancing institutions' reputations? One solution to this problem lies in the effective selection of candidates for entry into tertiary education, thereby maximising chances of success throughout the years of study.

A variety of factors complicate predictions of success in tertiary studies. Socio-economic status, motivation, study skills, quality of secondary schooling, innate ability, geographical location and many other predictors play a role. At present, the most often relied upon method for selection of potentially successful students in Higher Education is the Academic Points Score, a scored system based on Grade 12 results achieved. However, APS (Academic Points Score) is strongly influenced by the quality of secondary schooling implicitly linked to a variety of factors such as teacher quality, curriculum development,

geographical location, presiding municipality and the financial status of the ward within which the school is located. Therefore, schooling is not necessarily a reliable indicator of future success and ability – results only indicate what the student was able to learn and achieve given his or her secondary schooling circumstances. In addition, it is common for large numbers of students to have similar or identical APS scores following their Grade 12 graduations, further complicating the task of differentiating between those most likely to succeed. Due to the highly differentiated quality of schooling throughout South Africa and the aforementioned issues, further criteria may be required in order to ensure the selection of the most successful candidates for tertiary education. It is possible that the use of cognitive type assessments in order to differentiate between high and low cognitive potential candidates, in conjunction with previously achieved results, could provide a workable, useful alternative to current selection procedures. Such a method should allow institutions to differentiate between students who have achieved similarly in secondary education. However, the proposed use of this method should, first and foremost, be assessed for its relevance and ability to reliably and consistently predict future success in a manner which effectively aids current selection procedures.

The purpose of this study is to examine the relative performance of a cognitive instrument in comparison to high school Grade 12 results (Academic Points Scores) in predicting first year academic success in a sample of students enrolled for National Diploma programmes at a University of Technology. The research will examine the total scale score and seven sub-scale scores of a cognitive instrument in comparison to Academic Points Scores obtained by students on completion of their Grade 12 high school certificate in order to better understand relationships between each of these predictors and first year success rates. Hopefully, the results will be valuable in informing and suggesting a way forward to optimise Higher Education selection procedures.

Chapter 2: Literature Review

Higher Education

The Current Context of Higher Education

At present, both secondary and tertiary (higher education) institutions provide a method of selection and certification for young people to pursue specific careers (Herman, 2010). In addition, these institutions act as a tool towards social and economic development (Kongolo & Imenda, 2012). This is particularly true in the South African context where years of isolation and entry into the global economy created a shortage of high-level skills in the labour market (Letseka & Malle, 2008), necessitating attempts at rapid production of a skilled workforce (Boughey, 2003). The situation is complicated by the fact that the call for skilled labour needs to be balanced with the equally significant need to broaden and facilitate access to higher education for previously disadvantaged persons (Boughey, 2003). South African higher education is subjected to a variety of conflicting tensions and pressures in post-apartheid South Africa times, many of which still have not been resolved.

Higher education institutions attempt to ensure individuals are both suited to, and competent for, social and occupational roles entered into following completion of the education process (Herman, 2010). This training and competency assurance has previously been the monopoly of universities, colleges and further education institutions (Sewell, 1971). Herman (2010) contends that education is intrinsically related to a society's mobility system, self-advancement in the hierarchy of social standing and advancement in occupations in a modern industrial society. Education, and particularly higher education, may therefore be seen as a type of cultural process, preparing young people to achieve status mobility, or movement in social position, through a form of certification process (receipt of degrees, diplomas, etc.) which act as a culturally institutionalised devices for career and job placement and remuneration and reflect perceived levels of competence (Ogbu in Herman, 2010).

Types of higher education institution.

South African higher education has transformed in the last 10-15 years to include three main types of tertiary institution (The International Comparative Higher Education and Finance Project, 2009): Universities, focusing strongly on academic capacities, the pursuit of knowledge, and research with higher numbers of post graduates; Universities of Technology, formerly known as Technikons, oriented towards vocational qualifications, the acquisition of applied knowledge and imparting skills required in the labour market and for specific occupations; and, lastly, comprehensive institutions primarily focused on teaching with some

research capacity and higher levels of post-graduates than Universities of Technology, offering programs found both in the Universities and the Universities of Technology (Kongolo & Imenda, 2012).

Universities of Technology were originally commercial and technical colleges, not considered part of the higher education sector. The primary focus was on the training mid-level skilled labour. They have since evolved and become included in the higher education sector through the provision of some post-graduate qualifications but still focused primarily on technical and practical skills as well as experiential learning. Therefore, they have maintained strong links with commerce and industry in planning and implementation of programs (Kongolo & Imenda, 2012). Du Pré (cited in Thanthia, 2007) describes Universities of Technology as being research informed, defining curricula around graduate profiles determined by industry and focusing on applied research into professional concerns whilst considering capability as important as pure cognitive skill. Universities of Technology draw a greater assortment of scholars in response to the diverse and changing real world (Du Pré in Thanthia, 2007). Syllabi and education emphases are reactive both to the dictates of industry and the pace of technology by making current knowledge and research useful within the changing global industrial context (Thanthiah, 2007).

Students choose specific institutions and types of institution (such as Universities of Technology) for a variety of reasons. It is likely that many of those electing to study at a University of Technology have a certain amount of common ground which informed their decision. Factors such as the image of the institution, space available, financial needs, social factors, security, facilities, housing and many others play a role in an individual's choice of institution (Kongolo & Imenda, 2012). Price (cited in Kongolo & Imenda, 2012) describes several reasons behind choice of institution: (a) Characteristics of the student including personal goals, financial needs, ability and interests; (b) Characteristics of the institution including academic, social and environmental variables such as location and; (c) The interaction between the student and the environment impacting projected success and satisfaction within the institution. Factors such as the institution, space within institutions, financial needs, social needs and variables, security, facilities, housing and many others play a role in an individual's choice of institution (Kongolo & Imenda, 2012).

Transformation in South African higher education.

Several factors are changing the context of South African higher education (Jordaan & Wiese, 2010). Following 1994, five key policy goals in higher education were identified: 1) producing graduates needed for social and economic development; 2) achieving equity in the higher education system; 3) increased diversity; 4) promoting sustainable research and; 5) the restructuring of institutions and the institutional landscape of higher education (Wangenge-Ouma & Cloete, 2008). In order to achieve these goals, several interventions were implemented. Amongst these were promotions for mass participation in higher education and mergers between institutions. Funding challenges were identified as one of the greatest barriers to effective attainment of these goals (Wangenge-Ouma & Cloete, 2008) and therefore new financial schemes and funding models were introduced.

Mergers.

Mergers between institutions were introduced with the goal of assisting in changing perceptions of historically Black universities as inadequate (Letseka & Malle, 2008), as well as promoting rationalisation of programmes, collaboration and building of new institutional identities (Council on Higher Education Advice and Monitoring Directorate, 2009). This process mirrors the mergers undertaken by European institutions over an extended period of time, shifting emphases of some institutions to technical applications and research (Kongolo & Imenda, 2012).

The final processes and effects of such mergers, regardless of the original goal, are dependent both on governmental and institutional policies, with mandates from both sides determining merger success or failure (Sehoole, 2005). Resistances within institutions, for any reason, can impact the later success or failure of the merger as well as the institution's reputation, quality of schooling (Hay & Fourie, 2002) and, therefore, admissions levels and quality and competency of the persons exiting the institution.

Several reasons have been stated for the mergers experienced in South Africa following the apartheid regime (Hay & Fourie, 2002). Factors cited include: fragmented institutions and systems as a result of the 'old regime'; inequities in the previous system; under-prepared students due to socio-economically disadvantaged academic secondary institutions; poor quality of secondary schooling resulting in lower pass rates and access; unequal distribution of resources amongst institutions; poor economic growth and the declining of state subsidies; legislation such as the labour relations act resulting in increased

expenditure on salaries for more permanent staff; new types of institution and modes of delivery of knowledge (e.g. online learning); increased competition between institutions and; declining student enrolments leading to the promotion of mass participation in newly merged institutions. For the aforementioned reasons and following declines in enrolment in tertiary education during the late 1990s, a governmental decision was made to merge certain institutions "in order to", according to the Minister of Education at the time, "avoid duplication of service provision between institutions, enhance academic portfolios, increase quality of service provision, create a heterogeneous culture of education and attempt to increase student numbers, particularly amongst previously disadvantaged groupings" (Hay & Fourie, 2002).

Mass participation.

Promotion of mass participation in higher education post-apartheid attempted to reflect a mandate requiring enrolment to mirror South African population demographics. Increases in participation and promotion of mass participation necessitate greater thinking regarding the diversity of student bodies in South Africa. Consciousness of previously marginalised groupings is necessary (Smit, 2012), particularly since increased enrolment in South African tertiary institutions has been primarily amongst previously disadvantaged persons between 18 and 24 years of age (Mdepa & Tshiwula, 2012). Promotion of mass participation is not an exclusively South African phenomenon. Similar drives towards mass participation have been evidenced globally, particularly in relation to equality of access (Akoojee & Nkomo, 2007). Global participation in higher education has grown from 19% in 2000 to 26% in 2007 with further projected increases (Smit, 2012), with over 60% of the age cohort enrolled in higher education in parts of North America and Western Europe (Altbach, Reisberg & Rumbley in Smit, 2012).

Enrolment in South African higher education institutions has stabilised since an initial drive to mass participation, despite limited access due to financial reasons (Wangenge-Ouma, 2012) and a report released by the Department of Basic Education (2010) outlined the demographic statistics in higher education in 2009. In that year, 837,779 students were enrolled in public higher education institutions in South Africa, 316,349 of which were enrolled in Distance Institutions. Of these students 78.6% were Black African, Coloured, Indian or Asian in ethnicity, the majority of whom had a home language other than English and 57.1% were female (Department of Basic Education, 2010). Increases in enrolments and graduations in the past ten years have been noted in education statistics (Council on Higher

Education Advice and Monitoring Directorate, 2009). However, some still argue that the qualifications being produced are not relevant for the labour market and that far too few qualified graduates are being produced (Letseka & Malle, 2008), calling into question the value and long-term utility of the expenditure by the public and government on higher education in the realities of today's economic world.

Current success rates in South African higher education.

In 2008, South Africa's tertiary institutions presented one of the lowest graduation rates in the world at around 15% (Letseka & Malle, 2008) while in previous years from 2004 and 2007, a graduation rate of 16% was evidenced across all three types of tertiary institution (Universities, Universities of Technology and Comprehensives) (Council on Higher Education Advice and Monitoring Directorate, 2009). About 50% of a sample of 12,000 students enrolling in the year 2000 dropped out for a variety of reasons before 2003 (the expected year of completion) and a further 28% failed to complete within the usual three years (Council on Higher Education Advice and Monitoring Directorate, 2009). Universities of Technology are particularly hard hit, with some estimating that one in every two students dropped out between the years 2000 and 2004 (Letseka & Malle, 2008). However, figures must be interpreted with caution, since, for many years, authors have failed to find consensus on the definition of 'drop-out' and a variety of leaving behaviours have been combined, and classified, as 'dropping out' (Tinto, 1975).

Disparities in success rates exist between gender, socio-economic status, racial and other demographic groupings. Graduation rates of White students are approximately double those of Black students, despite Whites making up a lower percentage of the general student population (Letseka & Malle, 2008). Between 2001 and 2004, the majority of students graduating where White, a figure considerably higher than that of any other ethnic group and Black students evidenced the lowest success rates (Letseka & Malle, 2008). In addition, approximately 70% of the families of students who dropped out between the years 2000 and 2004 were classified as 'low socioeconomic status', with Black African families being particularly poor, often exhibiting earnings of R1600 or less per month, necessitating their children to work whilst studying (Letseka & Malle, 2008). Since the provision of National Student Financial Aid Scheme (NSFAS) loans is often insufficient to meet the tuition fees, accommodation fees and living expenses required for tertiary education, many students struggle to meet their basic needs whilst studying (van Harte, Ngolovoi, & Marcucci, 2006).

Students may leave institutions due to academic failure (the most common perception of dropping out) or, alternatively, due to transfer to another institution, voluntary leaving, taking a temporary break from studies, financial reasons or other factors. This multiplicity of leaving behaviours could be causing an overestimation of drop-out rates and have long created difficulties in targeting specific high risk population groups for intervention or further study (Tinto, 1975). Students from previously disadvantaged backgrounds or lacking in prior socialisation, schooling or attainment, are often referred to as previously disadvantaged, non-traditional, under-prepared or minority students, despite gaining near majority status worldwide in higher education institutions (Smit, 2012). Students labelled as previously disadvantaged are often seen to be lacking in resources, for example, in South Africa, students often enter higher education following inadequate secondary schooling, immediately putting them at risk to struggle with their studies (Smit, 2012). Lack of success is often viewed as being the result of some form of deficiency in these students, for example, cognitive, emotional or motivational deficiencies, or due to some external barrier such as culture, socioeconomic status or familial background (Smit, 2012). However, in the context of the promotion of mass participation in South Africa, little attention has been given to potential factors such as secondary education standards, cognitive ability and attitude towards studies.

High drop-out rates and non-completion cost the National Treasury approximately R4.5 billion in grants and subsidies in the early 2000's, with little or no return on investment (Letseka & Malle, 2008) and spending on higher education in 2008 was over R13 billion – a figure projected to increase (Council on Higher Education Advice and Monitoring Directorate, 2009). Despite the apparently growing expenditure, funds allocated to tertiary education have actually been declining steadily since 2004 (adjusted for inflation) and, in 2009, tuition fees as an alternate funding source accounted for 33% of government tertiary institutions' income (Council on Higher Education Advice and Monitoring Directorate, 2009). Statistics such as these highlight the importance of selecting candidates for success in order to facilitate a return on governmental, personal and institutional expenditure on education.

Structural reorganisations such as mergers, and attempts to balance financing, access and success, have become key issues in South Africa's transformation of higher education (Akoojee & Nkomo, 2007). Tertiary institutions need to become increasingly effective, financially stable and accountable to fit into a new context (Jordaan & Wiese, 2010),

particularly since one of the consequences of this new context is strong promotion of mass participation to remediate previous discrimination. Despite these efforts, drop-out rates and non-completion remain a significant issue in South African higher education.

Motivations for Entry Into Higher Education

Aside from self-realisation and personal satisfaction, higher education has been seen as an opportunity for increased wealth, power, prestige, increased social position and entry into valued occupations to provide a better life for the student and his or her family (Sewell, 1971). Following secondary school, students are immediately faced with complex choices: Higher education vs. employment and, if choosing higher education, which institution and course of study (Jordaan & Wiese, 2010). Hawkins, Best and Coney (cited in Jordaan & Wiese, 2010) describe a variety of internal and external factors influencing decisions to attend a higher education institution. External factors include culture, social class, reference groups, organisational marketing and family beliefs. Internal factors comprise primarily of demographics (including gender, ethnicity and age), perceptions of higher education and learning, motivation, personality, emotions and personal and familial attitudes to education.

As far back as the 1960s an inconsistency has been noted between encouragement to achieve, expectations and the realities of limited opportunity (Clark, 1960), a tension which is still prevalent in modern times. The nature of knowledge as gained from higher education, however, is changing. Knowledge can no longer be seen as a commodity separated from social or economic pressures, but is now subject to marketing influences and the pull of the current labour market (Pasternak, 2005). In addition, social advancement has become a strong motivator, particularly in developing countries (Andrew, Bamford, Pheiffer, Artemyeva, & Roodt, 2005) with learning capacity and education being strongly linked to later earning power (van der Merwe, 2011). Although future income levels are a strong motivator for entry (Andrew *et al.*, 2005), these beliefs are not always thoroughly interrogated. Therefore, students are often not able to meet the cognitive, emotional and social demands of higher education.

Students have adopted a more ‘consumerist’ approach to choice of institution and decisions to enter higher education. Price related issues and marketing are now important to institutions. Marketing campaigns now strongly influence both the decision to enter higher education, course of study and choice of institution (Kongolo & Imenda, 2012). In addition to cost-benefit analyses, perceptions of the outcomes of secondary education, encouragement to

higher levels of education by significant others and occupational aspirations still strongly impact the likelihood of entering tertiary institutions (Sewell, 1971; Kongolo & Imenda, 2012; Jordaan & Wiese, 2010).

Diversity of Students And Its Impact In Higher Education

South Africa is characterised by diversity in students. Demographic diversity in the form of race, gender, ethnic heritage and geographic location, amongst other factors, may impact selection procedures, potential to succeed in higher education and final throughput rates of tertiary institutions in ways not yet fully understood. The Human Resource Development Strategy of the South African government was initiated as a 2010 to 2030 plan of action, outlines, strategic goals and other foci. The purpose of this strategy was to ensure equitable outcomes in education and training, particularly promoting diversity and increases in 'scarce skills' such as medicine and engineering (Mdepa & Tshiwula, 2012). However, as current statistics on success rates suggest (Letseka & Malle, 2008), retention and throughput, particularly of Black students, is worryingly low (Mdepa & Tshiwula, 2012), mitigating for a re-examination of selection procedures within tertiary institutions.

Participation rates may be calculated by percentage of the general population who enrol in higher education. For Black South Africans, only 13.3% participate in higher education, in comparison to 56.9% of White South Africans and 44.9% of Indians. This difference is most pronounced at the post-graduate level (Council on Higher Education and Higher Education Quality Committee, 2012). A partial explanation for such statistics relates to higher dropout rates amongst Black students in the Secondary education system. The Council on Higher Education (CHE) (2012) also published statistics for the years 1998 to 2009 for gender and national proportions in higher education institutions. In terms of gender, 56% of higher education students in 2009 were female in comparison to 51% in 1998, a difference which is reversed at post-graduate level where more men than women are enrolled. A variety of nationalities are represented in South African higher education institutions with the majority being South African nationals (86%). However, from 1998 to the present, the proportion of foreign nationals in South African institutions has increased, adding to the challenges of diverse languages, backgrounds and secondary schooling experiences already experienced within the South African higher education context. (Council on Higher Education and Higher Education Quality Committee, 2012).

Access to higher education presents a number of barriers for students within the diverse population of South Africa. Despite drives toward more inclusive participation and mass participation, higher education enrolment is still significantly lower for Black students in South Africa partially due to poorer primary and secondary education in certain areas affecting the Grade 12 results required to achieve entry (Mdepa & Tshiwula, 2012). Black students are also experiencing lower pass rates in South African institutions (Letseka & Malle, 2008). Students from previously disadvantaged backgrounds tend to be underrepresented in higher education institutions (Mdepa & Tshiwula, 2012). Previously segregated education under the apartheid regime utilised the concept of Bantu education – an environment of unequal resources, a cognitively impoverished curriculum and the massive under-education of the majority of the South African (i.e. non-White) population (Heugh, n.d.). This legacy had a profound effect on the initial development and home environments of a large portion of the South African population which may have affected later success in higher education following the promotion of mass participation in an attempt to redress prior inequities.

The contentious issue of language of tuition as it relates to success in education continues to pose a challenge to single-language higher education institutions, particularly with the advent of a more multilingual approach to primary and secondary school teaching (Mdepa & Tshiwula, 2012). During the apartheid era, tertiary institutions and secondary schools were divided according to race (Black and White), with White institutions dividing according to language (English and Afrikaans) (Madiba, 2010). After 1997, a policy of mother-tongue education and bilingualism was introduced in order to balance mother tongue education with the acquisition of a second language (generally English) amongst school pupils (Heugh, n.d.). Some evidence does suggest that linguistic, academic and social advantages are associated with bilingual schooling (Heugh, n.d.). However, despite the benefits of bi- and multi-lingualism, barriers do exist. In a case study of the University of Cape Town (Madiba, 2010), findings indicated that Black students, in particular, agreed that a common language of instruction was required, but also indicated difficulties with English (the language of tuition) which impacted their success rates and created frustrations due to miscommunications and misunderstandings between lecturers and students. In the same study, Black students, particularly those from impoverished backgrounds, indicated that they were embarrassed to ask questions during lectures as they were afraid of White students and more privileged Black students making fun of their accents or lack of proficiency in English.

Such factors must surely influence success in tertiary education and point to a larger social challenge of language bifurcation between ‘advantaged’ and ‘disadvantaged’ schools and schooling areas. Remediation of historical disadvantage, inadequate schooling and language ability requires the provision of alternative forms of selection into higher education. Institutions, for a variety of financial, and other, reasons, need to select potentially successful students whilst allowing for background and prior schooling differences in language in particular. Potentially, language remediation should occur during tertiary study following selection of those most likely to succeed.

Factors Impacting Success in Higher Education

Given the wide variety of factors which are likely to impact success in higher education, attempting to predict success through any single method is not reasonable. To further complicate the issue, success in higher education can be measured in a variety of ways including throughput rates, grade point averages, continuing with post-graduate study and so on. Which factors most strongly influence success depend upon what method of measurement is used (Kuh, Kinzie, Buckley, Bridges, & Hayek, 2007). However, across multiple studies, certain factors have been shown to have a consistent impact on success, regardless of method of measurement.

International studies since the 1980s (Scarr, 1981) have shown that family background affects education and academic self-concept (Chapman, Lambourne, & Silva, 1990). Family background has also shown correlations with choice of industry and thereby directly or indirectly income (Hoogerheide, Block, & Thurik, 2012). Cronbach (1984) found that environmental factors, culture, gender and ethnicity affect scores on psychological and other assessment measures but that these factors are moderated by parental upbringing and socio-economic status which can negatively impact success in education even when ability is controlled for (Sewell, 1971). Rural and low socio-economic grouping students are often under-prepared for tertiary education due to insufficient instruction in mathematics and sciences, ill preparedness to deal with the language used as the medium of education being different from their home language and lack of career guidance in poorly resourced secondary schools (Mdepa & Tshiwula, 2012).

A possible explanation for lower academic performance is that low socio-economic status children tend to perform more poorly in selective attention, working memory and cognitive control tasks, significantly finding that language abilities and socio-economic status

are strongly correlated (Jednoro, *et al.*, 2012), Such findings potentially provide a partial explanation for differences in educational outcomes due to brain structure and general cognitive factors influencing, particularly, language skills, but require significantly more research to examine direction of mediation and causality (Jednoro, *et al.*, 2012). Factors influencing such success in higher education which are present prior to enrolment and commencement of studies include demographics such as ethnicity and gender, peer support, family support, motivation to learn, academic preparedness and potential choice of course (Kuh *et al.*, 2007). However, authors have noted that background characteristics are not always a good predictor of later success or failure but are a starting point for understanding student retention and success (Kovacic, 2012).

Intrinsic cognitive and hereditary factors also play a large role. In an early exploration of between-person differences in cognitive ability, Pearson, in 1903, examined sibling differences in cognitive ability as per rating by teachers finding a 0.5 correlation, a similar finding to that for physical characteristics such as height (Tucker-Drob, Harden, & Turkheimer, 2009). The same authors note that general theories and research suggest that cognitive abilities are essentially hereditary but may be cultivated in stimulating, enriched environments thereby influencing their expression and later effect on educational achievement in combination with within-person factors such as personality and motivation.

Within-person factors including personality traits such as conscientiousness, openness to experience, intellectual ability, achievement-motivation and learning styles have all been shown to impact students' success rates in higher education institutions to some degree and in some direction (Busato, Prins, Elshout, & Hamaker, 2000). Engagement in effective educational practices, individual characteristics of the student and the characteristics of the institution (including programs on offer), rules and regulations of the institution and a variety of other factors also impact how successful students are likely to be (Kuh *et al.*, 2007).

Certain groups of individual factors have been found to predict success fairly well. Factors impacting success include cultural and familial attitudes, including those towards time, teachings of cooperation rather than competition and cultural traditions affecting motivation to perform well on tests (Cronbach, 1984). Individual characteristics related to intelligence such as critical thinking have demonstrated strong relationships with both secondary and tertiary education results (Bauer & Liang, 2003). Other individual characteristics such as home environment (e.g. socio-economic class, parenting styles, etc.)

and school context (e.g. quality of instruction) impact likelihood of later success in tertiary education systems (Schiefele, Krapp, & Winteler, 1992). More specifically, factors relevant to success in higher education include cognitive factors, which have been shown to explain 25%-30% of variance in academic achievement in a population of German students (Quack in Schiefele *et al.*, 1992), motivational factors and specific interest in subject areas studied (Schiefele *et al.*, 1992). Certain measures of emotional intelligence have also been found to predict academic success. However, these do not yet represent a reliable or completely valid measure of educational, work and relationship success and development as a potentially useful tool is impeded due to conflicting research findings (Barchard, 2003).

Approaches to learning and medium of instruction may also impact how successful students are in higher education. Busato *et al.* (2000) found that a perceived heavy workload and less freedom in learning were associated with a 'surface' approach to learning tasks. Such a 'surface' approach, as opposed to 'deep' approaches which use elaborate strategies, is negatively associated with success in learning. Recent advances in instruction, including attempts to make use of more electronic materials and learning platforms, have been relatively unsuccessful as it would appear that face-to-face classes and tutorials are more important correlates of success than the mere delivery of information through other platforms, such as online blogs or e-mailed tutorial letters (Saunders & Klemming, 2003).

In a large-scale study of the influence of various personal factors and learning styles on academic performance, significant correlations were found between academic and exam success and traits such as conscientiousness, achievement-motivation and undirected learning (Busato, Prins, Elshout, & Hamaker, 2000). However, these correlations, although significant, generally explained only around 4% of variance or less in academic performance. Other studies have found small but significant negative relationships between end of first year results with extraversion and satisfaction with personal and social activities on campus as well as small but significant positive associations with conscientiousness (Bauer & Liang, 2003). A slightly stronger significant positive correlation was found between end of first year results and critical thinking skills, although only around 6.5% of variance in end of first year results was explained (Bauer & Liang, 2003).

Utilising Discriminant Function Analysis, Powell, Conway and Ross (1990), found certain factors which discriminated better than others in predicting student success. Persistence, marital status (married students) and need for success were all found to

discriminate well between successful and unsuccessful students whilst need for support being low seemed to indicate greater likelihood of success in studies (Powell, Conway, & Ross, 1990). In a study utilising a sample of students from a private Midwestern American university, Pritchard and Wilson (2003) found that although demographic variables (age, gender, high school scores, Scholastic Aptitude Test scores, level of study and parents education background) alone did not significantly predict general points average in college, the combined effect of all these variables did account for 22% of the variance in college results. In the same study, level of study and parental education background combined accounted for 12% of variance in tertiary results while the addition of a variable "social health" had a significant impact raising this figure to 35% with a similar finding for the addition of emotional health. These findings seem to indicate that social health and emotional health have a profound effect upon tertiary results, at least in these students (Pritchard & Wilson, 2003). However, it remains that such variables cannot be utilised for selection into higher education institutions, as such, although variables such as these may have an effect on educational and cognitive functioning, it remains that academic and cognitive criteria appear to be the better predictors of later success. Demand for higher education has increased rapidly and is exceeding availability, making some form of differentiating measure for selection necessary (Potential Assessment: A Historical Overview, n.d.). The wide variety of socio-economic, ethnic and language groupings in higher education emphasises the importance of this strategy being fair, unbiased and effective, indicating that a culture-fair cognitive test may be appropriate (Potential Assessment: A Historical Overview, n.d.). Clearly, an enormous variety of factors have been implicated for prediction of success in Higher education. However, overall, certain trends appear in this data. It would seem that cognitive function consistently accounts for the majority of variance in academic performance. This relationship may be moderated or partially mediated by education and background, including preparedness, language and schooling quality as well as educational practices and home life, all of which are responsible for smaller percentages of variance. Within-person factors such as internal motivation and personality may, again, impact factors such as academic attitudes and preparedness, affecting the utilisation of cognitive ability. The general model emerging appears to indicate that cognitive ability is a driving force of sorts with the utilisation and expression thereof being, to a certain extent, guided by other external and internal factors.

Cognition and Intelligence

Definitions and Theories Of Intelligence

Cognitive psychology is based in the study of how people think, perceive, learn about things, remember and think about information (Sternberg, 2006). Since the processes of the mind cannot easily be known, cognitive psychology and cognitive assessments are concerned with inferring knowledge of processes of the mind through measurement and inference (Goldstein, 2008). With rationalist and empiricist roots, cognitive psychology more recently focused on information processing and human reasoning, two concepts closely related to that of 'intelligence' (Sternberg, 2006). Since the advent of the computer age in the 1970s, cognitive psychology has largely re-focused on conceptions of the mind as an 'information processor', becoming increasingly scientific and empirically based and providing ample opportunity for both experimentation and the development of valid and reliable assessments (Hunt, Lunneborg, & Lewis, 1975).

Intelligence theories are often based in the cognitive psychology paradigm, with a particular emphasis on the information processing standpoint in the modern age. Intelligence is an extremely global term depicting a concept which represents multiple theories and hundreds of different factors referring to verbal ability, non-verbal abilities (Hunt *et al.*, 1975), working memory (Cowan, Elliot, Saults, Morey, Mattox, Hismjatullina & Conway, 2005), processing capacity (consideration of the complexity of relations processed in parallel from an information processing standpoint) (Andrew *et al.*, 2005; Andrews & Halford, 2002), musical and interpersonal ability (Azarmi, Jahangard, & Movassagh, 2012) and other definitions of the concept of intelligence.

Intelligence, although lacking a single unifying decision, is a key aspect of study in the cognitive paradigm, leading to the use and study of psychometric cognitive assessments, many of which have been standardised for use in applied settings such as industry and education. Individual standardised assessments are strongly linked with specific theoretical orientations of intelligence, of which a large variety exist (Anastasi & Urbina, 1997).

Sternberg (2006) defined intelligence as the capacity to learn from experience, adapt to the surrounding environment and enhance learning through meta-cognitive processes. Prior to such definitions, psychometric and cognitive theorising on intelligence and cognition was initiated by Spearman (cited in Sternberg & Pretz, 2005), who proposed a general (*g)* factor of intelligence. Thorndike proposed a similar theory of learning and intelligence to that of

Spearman, focusing on general, overarching factors in intelligence which account for a wide range of abilities and skills (Sternberg & Pretz, 2005).

Gardner, on the other hand, proposed that intelligence is pluralistic in design, conceptualising multiple intelligences and necessitating a re-thinking of teaching and learning approaches (Bakić-Mirić, 2010). Gardner's multiple intelligences theory was developed primarily in response to traditional, one-dimensional, conceptualisation of the construct of intelligence put forward by theorists such as Spearman and Thorndike (Azarmi, Jahangard, & Movassagh, 2012). Gardner, therefore, defined intelligence as a bio-psychological potential to process information which can be activated in a cultural setting thereby allowing the solution of problems or the creation of products of value within that culture. This theory initially identified seven competencies: Mathematical-Logical, Visual-Spatial, Bodily-Kinaesthetic, Musical, Interpersonal and Intrapersonal and, later, natural intelligence – qualities generally not tapped by conventional standardised intelligence assessments (Gardner in Azarmi *et al.*, 2012).

Sternberg and Pretz (2005) later identified three fundamental components of cognition and intelligence in a triarchic theory: (1) comprehension of experience or encoding of stimuli; (2) eduction of relations (inference) and; (3) eduction of correlates (application of inferred rules to a new situation). Similarly, intelligence has also been constructed as the sum total of all cognitive processes including planning, coding information and attention arousal, with those required for planning having a relatively higher status, particularly in reference to selection and execution of plans (Das, 1986).

The conception of intelligence as higher order cognition or information processing phenomenon, in which meta-cognitive factors of monitoring and control are fundamental, focused less on the basic elements of intelligence and more on the over-arching ability of humans to think about and monitor their own cognitions and decision making (Necka & Orzechowski, 2005). Questions of suitable measurement methods, criteria and standards which should be utilised to measures these fundamental and over-arching concepts unique to specific theories has become of interest to cognitive theorists.

Cronbach (1984) contended that there should be a unified psychometric definition of intelligence obtained through cognitive psychometric testing (i.e. what intelligence is would be partially defined by what cognitive intelligence tests measure). Psychometrically, intelligence or cognition can be defined by statistical agreement between tests – those doing

well in one area or test tend to do well on another (Fischer, *et al.*, 1996). Predictive validity of cognitive tests is often established using schooling grades (secondary and tertiary) which are assumed to be an indicator of underlying intelligence and competencies (Fischer *et al.*, 1996), although this criterion is subject to considerable influence by other factors such as quality of schooling and home environment.

Psychometric conceptualisations of intelligence have been strengthened through findings of positive correlations between almost all reliable measures calling for retrieval, manipulation, processing of information or any other form of cognitive activity – persons performing well on several cognitive tests fall on the higher side of a continuum labelled 'intelligence' (Murphy & Davidshofer, 1998). The psychometric measurement of cognition provides a quantification of an observed behaviour or skill (such as reasoning) through which we may make inferences about an underlying construct of intelligence or intellectual ability and, in doing so, partially defines the construct in question.

Psychometric understandings of intelligence are tempered through examination of basic theories of cognition and intelligence in order to more fully understand the elements and over-arching concepts measured. For example, problem solving through acting on instructions is considered a component of intelligence which is widely utilised in cognitive tests of intelligence (Dillon & Schmeck, 1983). Another aspect to cognitive assessment is drawn from speeded responses wherein assessment of intelligence is partially based on the speed at which the individual processes information (Hunt, Lunneborg, & Lewis, 1975). Many cognitive tests require complex problem solving and inductive reasoning, thereby providing an assessment of higher order cognition (Necka & Orzechowski, 2005).

A variety of studies have demonstrated the relationship between intelligence or cognitive abilities and socio-economic status (Nettle, 2003), amongst other factors. Parental socio-economic status is often related to the intelligence scores of offspring, an effect not seen in adopted offspring, emphasising the potential hereditability of intelligence or cognitive capacity. This potentially indicates a relationship between social class and intelligence mediated by socio-economic status of environment and associated contextual factors (Nettle, 2003). However, others have previously found that achievement motivation, mediated by intelligence levels, better predicts social class membership – a relationship which disappears when the effects of intelligence are controlled for or removed (Bruckman, 1966). Clearly, it is difficult to disentangle the various effects of achievement-motivation and intelligence in

determining social class membership. More recently it has been noted that educational background and schooling in Western cultures, along with generally widespread use of the skills required for standardised intelligence tests in everyday life, are factors implicated in higher measureable intelligence levels in higher socio-economic groupings (Klein, Pohl, & Ndagijimana, 2007).

The association between socio-economic status and intelligence scores is considerably stronger in adulthood than at birth, hinting at a connection between intelligence and social class mobility and improvement, rather than a simple cause-effect relationship (Nettle, 2003). In addition, the consequences of cognitive assessments tend to have implications for career trajectory and path, educational paths and socio-economic progress (Verney, Granholm, Marshall, Malcame, & Saccuzzo, 2005).

Such relationships may simply be a product of selection on the basis of intelligence testing. Intelligence testing has been utilised for selection to elite education programs, bursary study at advanced institutions and similar developmental opportunities (White, n.d.). Cognitive assessments, despite not measuring all aspects of intelligence, have certainly been strongly correlated with schooling results in the past (Neisser, 1997), but the factors at play in this relationship are unclear. It is currently unknown whether this correlation is due to home and environmental influences improving intelligence levels and achievement through factors such as familial motivation, test-wiseness and improved teaching. Alternatively, higher intelligence parents could produce more achievement oriented, intelligent children. Further still, social class may affect measurement of intelligence through test-wiseness and exposure, or impact the relevance of assessments, thereby somewhat explaining these relationships. However, it remains clear that measurable cognitive concepts of intelligence do play some role in schooling achievement, although this relationship may not be clear at present.

Cognitive Assessments of Intelligence

Cognitive testing of intelligence usually comprises a series of cognitive tasks with a variety of verbal, non-verbal, mathematical and figural items requiring the use of different mental processing capacities (Dillon & Schmeck, 1983). While some tests consist purely of abstract problems, others focus on specific competencies such as arithmetic, reading, spatial reasoning, vocabulary, memory and general knowledge (Neisser, 1997), factors all strongly influenced by the schooling system and early childhood development and rearing. Many cognitive assessments have evolved to include concepts such as adaptation and learning

through teaching and learning prior to testing in order to ascertain how well the individual grasps new skills and concepts (Matarazzo, 1972; Sternberg & Pretz, 2005). Practicing real problem solving with feedback leads to higher test scores and improved problem solving skills with the extent and application of learning (or adaptation) giving an indication of cognitive ability (Pfeiffer, Feinberg, & Gelber, 1987; Foxcroft & Roodt, 2005).

The use of intelligence tests and cognitive assessments has permeated the school and industrial systems worldwide. Assessments are utilised for screening, diagnoses, selection and classification of students, student placement into gifted or remedial programs, program evaluation, vocational guidance, counselling, selection for higher education and program placements in higher education (Zeidner, Matthews, & Roberts, 2004).

However, much debate exists in the best or most correct way to measure intelligence. For example, Binet and Simon, often considered the originators of intelligence testing, proposed assessment of elementary psychological processes, such as reaction time and sensory discrimination, in order to assess ability in a modular structure (Anastasi & Urbina, 1997). Spearman, on the other hand, favoured a *g* or general factor of intelligence and stated that a great weakness in assessment approaches has been lack of an explanation for, and full definition of, 'intelligence' (Dreary & Smith, 2004). Such limitations curtail full understanding of any measurement of cognitive function and often lead to the circular logic found in psychometric definitions of intelligence, such as those of Cronbach, whereby intelligence is what is measured by intelligence tests and intelligence tests are such because they measure intelligence.

A distinction must be made between cognitive intelligence and aptitude tests alongside the learning or adaptation exhibited as part of the testing and achievement tests used in educational settings. Achievement tests concern themselves with mastery of specific knowledge or content areas (for example, final Grade 12 school leaving examinations) while aptitude and cognitive intelligence tests purport to measure the underlying characteristics of intelligence such as reasoning, adaptation, learning, speed of information processing, ability in certain areas, etc. in order to predict performance on a wide variety of tasks (Murphy & Davidshofer, 1998).

Working memory, which some consider an aspect of intelligence, illustrates some difficulties in assessing intelligence and cognitive functioning. In most assessments of working memory, analysis and interpretation of results is problematic due to the reliance on

multiple skills (e.g. knowledge of vocabulary as well as verbal reasoning) being used in single tests of working memory. This somewhat confounds the researcher's ability to separate integral aspects of the process since the assessment of working memory is at least partially reliant on multiple skills such as vocabulary, language, familiarity, etc. (Cowan *et al.*, 2005). It is essential to approach any measurement of intelligence from a strong theoretical stance, in order to disentangle confounding and additional factors such as prior education, creating a need for separate assessments of each factor or a method of disentangling dynamic intelligence from set educational gains primarily utilising processes of memory.

It is essential to achieve a clear distinction between cognitive intelligence tests and achievement oriented assessments, such as those utilised within the educational system. Intelligence tests should not contain large numbers of achievement items which rely on previously acquired knowledge, although they should be able to reflect increases in intelligence gained through schooling (Murphy & Davidshofer, 1998). Scores on cognitive tests of intelligence have largely been standardised, researched and adapted cross-culturally to reflect an individual's performance relative to age, socio-economic or cultural grouping while achievement tests draw comparisons between what knowledge the individual exhibits and what they should have acquired (Foxcroft & Roodt, 2005).

The Flynn effect.

Intelligence test scores have been rising consistently and substantially worldwide, across a variety of cultures at around 3-5 IQ points per decade (Teasdale & Owen, 2005) and is generally ascribed to biological factors such as nutrition or social factors such as educational development (Neisser, 1997). However, it is unknown whether this gain is due to increases in test-wiseness affecting results or due to actual increases in intelligence (Neisser, 1997). These changes have led to world-wide debate on the causes, nature and implications of such increases (Neisser, 1997). A variety of authors, referenced in Wicherts *et al* (2004) have noted that these increases are primarily in areas of fluid intelligence rather than crystallised intelligence assessments such as verbal IQ, causing debate as to whether or not general (*g*) factors of intelligence have, in fact, increased or whether the rise is due to general increases in test-taking ability, particularly in 'test-permeated' culture. Wicherts *et al.* (2004) conducted a factor analytical investigation into scores on five assessments of intelligence and considered whether gains were due to common factors or the hypothetical constructs the tests were intended to assess. The authors did not find a common factor apparently responsible for increases in scores on the Wechsler Adult Intelligence Scales in Dutch Adults between 1967

and 1999, but, after relaxing the parameters of their model, found significant gains in common factor sub-tests dealing with similarities and comprehension (Wicherts, *et al.*, 2004). However, in the same study utilising a sample of Danish draftees in the years 1988 and 1998 assessed on the Børge Prien's Prøve cognitive test, the authors could not find increases in latent intelligence due to factor mean differences between cohorts, thus contradicting the supposition that the Flynn effect is due to increases in latent intelligence (Wicherts, *et al.*, 2004).

In a closer examination of Wicherts, *et al.*'s study, Teasdale and Owen (2005) found small decreases in scores in the later period which corresponded to decreases in educational levels amongst the sample of Danish male draftees, providing possible support for the Flynn effect being due to environmental influences such as education impacting latent intelligence assessments such as Raven's Progressive Matrices. Utilising the same assessment and two others in Kenya on two groups of children, Daley, Whaley, Sigman, Espinosa and Neumann (2003), compared a 1984 sample with a 1998 sample. In this case an IQ gain of 26.3 points over the 14 years was found, considerably higher than that originally noted by Flynn (Daley, Whaley, Sigman, Espinosa, & Neumann, 2003). Again, the effects were larger on the test of fluid intelligence (Ravens Progressive Matrices) than those for crystallised intelligence (the Verbal Meaning Test, focusing on learned word meanings). Potential causal factors for the great increase were identified as: parental literacy; increases in nutrition; better health with less prevalence of, particularly, hookworm depleting iron levels associated with cognitive function; and, importantly, a recorded increase in maternal education during the time period of the study (Daley, *et al.*, 2003). In this case, a change in environmental and internal factors may be responsible for the observed increases in average scores. However, in general, it is not known precisely which factors are responsible for the increases noted by Flynn. However, questions regarding the cultural validity and applicability of such assessments still remain.

Culture fair testing.

Despite widespread standardisation and adaptation of cognitive assessments, questions around validity and reliability in predicting future academic performance and intelligence for non-Western cultural groups still exist. Although provision of concrete evidence for cultural biases in cognitive testing has proved difficult, it has been noted that African and Hispanic Americans show lower scores on cognitive tests than Caucasian Americans do (Verney *et al.*, 2005). Foxcroft and Roodt (2005) observed that construct equivalence, method equivalence and item equivalence are all necessary to ensure no bias

exists between different cultural or ethnic groupings. Achieving levels of equivalence make designing or adapting culture-fair tests a difficult, time-consuming and resource-consuming task (Anastasi & Urbina, 1997). True equivalence may not be possible, given how little we understand about the factors at play in differential achievement across cultural groupings.

Culture-fair testing has promoted several methods of by-passing difficulties such as lack of test-wiseness or lack of familiarity with testing. However, these are often circumvented by the multitude of factors at play in differential performance between cultures. Factors such as nutrition, schooling, childhood rearing and membership of technology driven cultures with differential accessibility to information (Neisser, 1997) further complicate relationships. These factors almost certainly partially account for better performance in developed countries and potentially poorer performance in developing countries. Possible explanations for such differences between Western developed countries and developing countries include potential genetic factors on the one hand and environmental factors such as schooling, culture-fairness, verbal and language issues on the other (Klein, *et al.*, 2007).

Lower scores in cognitive assessments by minority groups in the United States of America may be partially attributed to situational factors such as stress and anxiety due to stereotype threat, or the awareness one's cultural group may be viewed negatively, rather than due to intrinsic factors (Klein *et al.*, 2007). There is ongoing debate regarding the presence and effect of cultural factors and stereotypes regarding factors such as attitudes, values, beliefs and behaviours of non-European groupings to cognitive assessments and the effect on standardised (Eurocentric) assessment results (Verney *et al.*, 2005). Due to this lack of understanding of the factors at play in cultural variations, attempts to create and modify tests to be 'culture-fair' have not always been successful (Anastasi & Urbina, 1997).

Efforts have been made to create culture-fair tests in which the test only includes familiar experiences common to all cultures (Compindex: Nonverbal Ability Test, n.d.). For example, attempts have been made to eliminate the influence of culture by focusing on general capacities which do not require any specific knowledge of language, ideology or form of logic (Klein *et al.*, 2007). Despite this, it has proved near impossible for a test to be culture-fair in all situations, and most 'culture-fair' tests still demonstrate group differences, with White Westerners tending to perform considerably better on standardised assessments (Eells in Klein *et al.*, 2007), albeit showing different inter-group patterns in disparity than culturally loaded assessments (Jensen in Klein *et al.*, 2007).

Cultural differentials in test performance can be minimised and controlled for through the production of culture-, ethnic- or gender- specific norms (Anastasi & Urbina, 1997), although the root of differential functioning in cultures may never be solved partially due to difficulties in disentangling genetic, biological and environmental factors. For this, and other, reasons the notion of culture-fair tests has been strongly questioned for many years (Scarr, 1981; Anastasi & Urbina, 1997; Foxcroft & Roodt, 2005). In attempts to develop culture-fair assessments, a variety of statistical and judgemental methods have been developed.

During the development of culture fair assessments, aside from specific norms, item analytic and response theories are commonly utilised in order to detect items prone to differential functioning. Differential item functioning (DIF), or the statistical concept of items responding differently dependent on cultural or other grouping, has largely replaced the term 'bias' (Kanjee, 2007) when considering fairness of assessments. Items are said to function differently if respondents from different groups with the same ability level have different probabilities of answering the item correctly (Magis, Raiche, Beland, & Gerard, 2011). Presence of DIF may necessitate the revision of such items using either judgemental or statistical methods (or a combination of both) as DIF indicates an item operates differently dependent upon the group an individual belongs to, creating bias (Kanjee, 2007). Kanjee (2007) noted that a logistic regression procedure may be utilised to compare multiple groups' responses simultaneously in identification of DIF, finding a higher detection rate for simultaneous comparison than two-group comparison. However, Kanjee (2007) also noted that when comparing multiple groups, different sets of items may be flagged for DIF, than in pair-wise groups, possibly necessitating a different definition of DIF for multiple groupings in the development of assessments in order to identify 'true' DIF items which require removal or revision in the development of culture and language 'fair' tests. Since identification of 'true' DIF may be difficult when comparing multiple groups, whether due to test function or statistical artefacts, caution should be utilised when attempting to produce 'culture fair' assessments and the interpretation of the results of such assessments.

Since culture permeates all environments, some argue that intelligence is partially rooted in culture, in terms of definitions and importance, environmental stimulation and shared views on the importance of cognitive development and education (Serpell, 2000). Despite difficulties in developing fairness and controlling for cultural, gender and linguistic bias, cognitive testing has grown in sophistication and is now used in a variety of contexts,

including industry and education, to assess persons from a wide variety of cultural, linguistic and socio-economic backgrounds (Foxcroft & Roodt, 2005).

Types of Assessments and Their Uses in Higher Education

Admissions using various selection criteria have implications for: (1) the applicants who are and are not accepted; (2) the academic standards of the institution and whether or not applicants will be successful in higher education; (3) the content and manner of teaching in the institution and; (4) the throughput or graduations rates of institutions (Cliff & Hanslo, 2009). Secondary school grades are still considered the best predictor of tertiary success, but are strongly influenced by factors other than knowledge or skills achievement and measure accomplishment rather than potential (Cliffordson, 2008).

Academic scores and school leaving exams only indicate levels of knowledge and thinking ability developed during secondary schooling and are strongly influenced by factors such as quality of schooling, socio-economic status and dispositions or personal characteristics of individuals and groups (Cliff & Hanslo, 2009) as well as teacher evaluations of the student as a whole (Carroll in Cliffordson, 2008). Issues such as these led to the Sutton Trust in the United Kingdom to argue for additional, holistic admissions testing (West & Rebecca, 2004). Cliff and Hanslow (2009) found that both academic and non-academic variables can be predictive of tertiary success in education. In a study at the Arabian Gulf University, a combination of academic assessment and interviews better predicted academic performance than the use of either alone (Al-Nasir & Robertson, 2001). The use of a personal history biographical questionnaire relating to home and school facilities and resourcefulness in seeking assistance in conjunction with a Placement Test in English for Educational Purposes and traditional (academic) selection methods were found to be useful in identifying high potential candidates in a South African university's Social Work programme (Ross, 2010). A Turkish study concerning an academic placement test found the achievement test to be predictive of success when applied in conjunction with school-leaving results to identify potential (Karakaya & Tavsancil, 2008). Although a successful history of alternate selection procedures does exist, disentangling secondary education quality, academic achievement as a predictor, current cognitive ability and cognitive potential promises to be a difficult task, necessitating consideration of a number of complex concepts.

Defining, and therefore assessing, potential is a complex task. In order for 'potential' to be assessed, it is required that some assessment of the idea of potential elicits performance of some kind which indicates ability to produce in the sector in which the individual has 'potential' to perform (Yeld & Haeck, 1997). However, assessment of potential for academic study cannot be separated from necessary minimum levels of academic proficiency, complicating tasks of attempting to separate poor quality of secondary schooling from potential for further study (Haeck, Yeld, Conradie, Robertson, & Shall, 1997).

Language ability (in the language of instruction) in particular can have a strong impact on the expression of potential (however it is measured), particularly in combination with levels of academic proficiency. Combining linguistic knowledge and proficiency is related to academic literacy, with language being communicative and interactional whilst requiring synthesising, extrapolation and interpretation of written and auditory information (van Dyk & Weideman, 2004). Minimum requirements of academic literacy and academic performance impact the expression of potential for a particular field of study, creating further complexity in predicting academic success and limiting ability to separate potential from the quality of prior academic and developmental experiences. Indeed, a number of the above mentioned assessments, as well as the South African National Benchmark Test, appear useful only as an adjunct to secondary schooling, subject to the same limitations should schooling have been inadequate, and useful only for developmental and diagnostic purposes rather than as an indicator of potential or alternative assessment (Yeld, 2007)

A study on the utilisation of an English and academic abilities assessment suggests that basing assessments, without having provided prior opportunity for familiarisation, is likely to blur the distinction between strong and weak candidates and result in generally poorer performance on the assessment (Yeld & Haeck, 1997). Therefore, in order to correct this deficiency, in development of an academic literacy and potential assessment, Yeld and Haeck (1997) promoted the use of a scaffolding approach, based on the Vygotskian concept of the zone of proximal development, which allows opportunities for the student to produce actions through an instructional and feedback process in order to assess potential for development rather than purely acquired skill. Such methods have been considered in cognitive assessments of potential almost since the inception of the zone of proximal development as a concept (Brown & French, 1979).

Academic achievement and cognitive assessments have both been successfully used to predict future academic performance and potential, despite a vastly different conceptual basis between the two (Hartas, Lindsay, & Daniel, 2008). Verbal and non-verbal cognitive intelligence tests are often inappropriately used as a primary indicator for identifying giftedness in students and are therefore often ineffective due to a failure to take into account cultural experiences and lack of opportunity to develop certain skills (Callahan, 2005). Therefore, more holistic assessments have been focused on in predicting academic and job performance.

Alternate assessments of future performance have been utilised in industry in an effort to create a more 'well rounded' assessment of competencies and abilities. For example, 360° assessments of multiple competencies have been utilised in the industrial/job performance setting. However, validity of such assessments has been strongly called into question, partially due to subjective, individual ratings being utilised to determine criterion-related validity (Darr & Catano, 2008). In the educational context, assessments of a variety of skills and abilities have been investigated in selections for success in higher education. For example, the University of Cape Town's Placement Test in English for Educational Purposes (PTEEP) was developed and fairly successfully utilised to assess potential coping with English as a learning medium by assessing constructs of vocabulary, metaphorical expression, inference and extrapolation, communicative functions of sentences, relations between texts, genre, separation of essential from non-essential information, understanding visual information and understanding of numerical concepts (Cliff & Hanslo, 2009).

The ability of logical thinking and abstract reasoning, often strongly represented in cognitive tests, to predict future academic and life success in applicants from non-Caucasian ethnicities has frequently been queried. In a study of applicability of the American Scholastic Achievement Test (the SAT), which is not a cognitive test but does involve high levels of verbal and numerical reasoning, to the United Kingdom population a large verbal score disagreement was found between Black and White applicants and the assessment, in general, did not strongly predict academic results for any groupings (West & Rebecca, 2004). Many cognitive tests, in efforts to reduce cultural biases, rely on non-verbal spatial and figural reasoning abilities purported to reflect general problem solving ability. However, these can be misleading when used in selection procedures but often still lead to unfair decisions in non-Caucasian population groups (Lohman, 2005). Ethnic discrepancies in cognitive assessment reliability and validity have led researchers to seek methods of assessment which minimise

such bias and maximise the ability to predict future learning ability in the educational context.

Concepts of 'learning potential' have permeated intelligence and cognitive testing in an effort to identify individuals able to profit fully from focused training (Cronbach, 1984). In their discussion of learning styles (predispositions to using certain cognitive information processing patterns), Dillon and Schmeck (1983) found that the final stages of cognitive development are often not reached during adolescence and individuals are forced to utilise processing at a more shallow level in all areas, particularly with regard to new content. The cognitive processes adopted during tests of cognitive ability relying on learning of new concepts and information during the test may provide indications of maturity of cognition, a characteristic desirable in selecting high-potential candidates (Dillon & Schmeck, 1983). Tests of cognitive potential may be useful in selecting high 'learning potential' candidates for tertiary education – a concept which may encompass both intelligence and cognitive maturity in both the verbal and non-verbal spheres.

Non-verbal reasoning tests require the respondent to reason using figures such as concrete objects or line drawings but often require certain amounts of verbal and/or mathematical knowledge in order to think about, and reason with, stimuli in the mind (Lohman, 2005). Studies of non-verbal reasoning assessments generally find that they are good indicators of fluid (de-contextualised) general intelligence (Compindex: Nonverbal Ability Test, n.d.), which is considered to be a relatively culture-free form of intelligence (Schaap & Vermeulen, 2008). However, non-verbal reasoning tests are subject to strong gender biases and, since they require analogous transformations such as mentally turning or rotating items, they are also prone to language proficiency biases (Lohman, 2005) as well as ethnic biases, leading to questions regarding their applicability in selection of high potential candidates (Hartas, Lindsay, & Daniel, 2008). Lohman (2005) argues that non-verbal items should be a secondary or tertiary factor in predicting academic performance despite the perception of fairness to diverse populations. This reasoning is as a result of demonstrated lower correlations of non-verbal items with academic outcomes in comparison to verbal and numerical reasoning items (Lohman, 2005).

Verbal reasoning tasks can be difficult to disentangle from verbal achievement tests since both tend to make use of analogies, reasoning, sentence completion, word comparison, and so on (Compindex: Nonverbal Ability Test, n.d.). However, both have potential in

predicting later performance in tertiary education, particularly when utilised in English, the generally accepted medium of instruction. Well-constructed tests using abstract, but relatively common, words are most useful for the measurement of verbal reasoning whilst reducing the impact of reading skill, prior knowledge and linguistic convention, thus minimising prior environmental effects (Compindex: Nonverbal Ability Test, n.d.). Some have argued that language processes operate independently of cognitive processes (Chomsky in Schaap & Vermeulen, 2008) while others contend that language processes and cognitive processes are inseparable (Sharrat in Schaap & Vermeulen, 2008). It is generally accepted that language styles significantly impact the manner in which a test (verbal or non-verbal) is developed and therefore have an impact on individual performance (Schaap & Vermeulen, 2008). Persons with high verbal ability should be sensitive to the nuances and information in written and oral speech (Hunt, Lunneborg, & Lewis, 1975), including those within word problems and vocabulary as found in cognitive tests and verbal academic achievement tests.

The important aptitudes for future success in education systems are current achievement in the relevant domain (as reflected by final secondary school results) and the ability to reason using a symbol system in which the new knowledge will be communicated (this ability is related to complex verbal and numerical abilities as well as 'fluid' or de-contextualised intelligence) (Lohman, 2005). The symbolic reasoning system in which the candidate should be more proficient depends greatly on the intended course of tertiary study. Lohman (2005) found verbal and numerical ability to better predict tertiary education success than non-verbal or figural groupings regardless of ethnic or cultural grouping. The Swedish Scholastic Aptitude Test has been successfully used to identify high potential candidates when used in combination with the secondary education academic results (Cliffordson, 2008). The Swedish Scholastic Aptitude Test in Cliffordson's (2008) study assessed both fluid reasoning ability (de-contextualised reasoning) and crystallised reasoning ability (developed skills), both of which are common components in cognitive intelligence tests. Using factor analyses, Lohman (2005) found that non-verbal reasoning ability was associated with general fluid or de-contextualised reasoning but that such skills were often not required for academic success, taking a back seat to verbal and numerical reasoning skills evidenced in crystallised reasoning ability and different forms of fluid reasoning assessments.

Academic Points Scores

Literature generally suggests that prior ability is a strong predictor of later academic success with higher secondary school achievement predicting success best in tertiary education (Kitsantas, Winsler, & Huie, 2008). Academic secondary school achievement on standardised school-leaving examinations are generally utilised for assessing suitability for tertiary study since they are considered to be indicative of general knowledge, academic readiness, thinking ability and subject-specific knowledge required for success further study (Cliff & Hanslo, 2009).

In South Africa, the Academic Points Score is utilised as an indication of Grade 12 achievement in subjects taken. A score is allocated dependent upon the percentage obtained in each subject, and specific courses require different levels of achievement per subject and total score (cumulative score). Two languages (one of which must be English), mathematics or mathematical literacy and life orientation are compulsory subjects and a total of six subjects (excluding life orientation) or seven subjects (including life orientation) are counted towards the final score. If a student has more than seven subjects the highest scores are utilised. Should a student have later repeated a subject the highest score is utilised. Points are allocated as follows (Department of Basic Education, n.d.):

Table 1:
Achievement (APS) levels in relation to percentages obtained

ACHIEVEMENT LEVEL	*ACHIEVEMENT DESCRIPTION*	*MARKS %*
7	Outstanding achievement	80 – 100
6	Meritorious achievement	70 – 79
5	Substantial achievement	60 – 69
4	Adequate achievement	50 – 59
3	Moderate achievement	40 – 49
2	Elementary achievement	30 – 39
1	Not achieved	0 – 29

The PIBSpEEx

The Potential Index Batteries and Situation Specific Evaluation Expert scales (PIBSpEEx) provide a comprehensive assessment package for assessing human potential (Erasmus,

2004). The PIBSpEEx cognitive scales (the behavioural scales are not considered here) are concerned with source competencies – constructs or dimensions of potential divided into broad areas of intelligence (Erasmus, 2004). In his design of the PIBSpEEx, and later refinement, Erasmus (2004) conceptualised cognitive intelligence as the ability to understand one's environment through conceptualisation, observance, reasoning, perception, comparison and other similar cognitive skills which one may apply in any context and are not wholly reliant on previous education and skill acquisition. For this reason, the PIBSpEEx is something of a merger between traditional cognitive intelligence assessments and dynamic learning potential assessments.

Cognitive assessments have conceptualised intelligence in a variety of ways. In the 'academic' context, for example, the General Scholastic Aptitude Test (GSAT) includes two verbal ability subtests and two non-verbal subtests and has been used to successfully predict performance in educational settings (Jenkins, 2004). However, this assessment relies fairly heavily on secondary school achievements and therefore does not provide an indicator of cognitive potential relatively free of schooling quality. For this reason, learning potential assessments are often utilised, particularly dynamic assessment which is designed to be process-oriented, focusing on learning taking place during the assessment process (Ruijssenaars, Castelijns, & Hamers in Murphy & Maree, 2006).

Since assessments have largely focused on static cognitive intelligence or capacities, theoretically some learners may not be permitted the opportunity to develop their full potential due to inadequate early experiences (Murphy & Maree, 2006). The Learning Potential Computerised Adaptive Test (LPCAT) was considered by van Eeden (cited in Logie, 2010) in predicting tertiary education abilities, but was not found to predict future success well. This non-verbal, computerised, dynamic test-retest assessment was designed as 'culture fair' and excludes any language component (Logie, 2010) and provides a true example of an assessment of learning potential relatively free of presence opportunities to develop cognitive skills.

More commonly used, traditional tests of cognitive intelligence such as the Wechsler Adult Intelligence Scales and age-appropriate variants, conceptualise intelligence and learning potential in a more static yet integrated manner. Such assessments utilised verbal and non-verbal material in terms of multifaceted, global capacities (Benson, Hulac, & Kranzler, 2010), but do not utilise a test-retest or learnt skill methodology, relying rather on present

skills and abilities. Non-verbal static cognitive intelligence tests, such as the Leiter International Performance Scale, Raven Progressive Matrices, General Ability Measure for Adults and Universal Non-verbal Intelligence Test, have made attempts at fairness between cultures by focusing only on non-verbal cognitive skills (Bell, 2013). However, these tests, in the context of predicting success in higher education, potentially negate important skills regarding verbal intelligence and functional behaviour in an educational context.

The PIBSpEEx conceptualises cognitive intelligence as consisting of potential, capacity, ability and input within the context of a functional area of behaviour which enhances harmony within the environment (Erasmus, 2004), thereby combining several of the intelligence assessment areas already mentioned. Erasmus (2004) also considered the concept of learning potential in terms of its application to the PIBSpEEx results: individuals have learning potential or ability in certain of the constructs, or dimensions, across the broad area of intelligence and therefore learning potential is confined to a particular field(s). This follows a fairly persuasive argument for testing of specific fields or domains of cognitive potential, rather than simply observing previously acquired knowledge or skills (Sackett, 2012). However, the PIBSpEEx does not operate as a true 'learning potential' assessment as it does not include continual instruction and adaptation (Murphy & Davidshofer, 1998), but rather relies on the explanation of concepts, assessing the ability to understand and apply (Erasmus, 2004) without comparing pre- and post-learning scores. The PIBSpEEx instead attempts to partially analyse 'containers' of cognitive learning potential in order to find in which areas or dimensions a particular individual exhibits potential and ability (Erasmus, 2004) within the required context (in this case higher education delivered in the English language), but does not concern itself with the size of differences in performance before and after learning as is used by dynamic test-retest assessments such as the LPCAT (Logie, 2010; de Beer, 2005).The PIBSpEEx was brought into selection procedures, primarily in industrial settings, on a larger scale after validation in the late 1990's (Potential Assessment: A Historical Overview, n.d.). The test underwent refinement and updating in the early 2000s. The PIBSpEEx now consists of psychological measures to determine aptitude, intellectual ability, social behaviour and emotional behaviour relevant to the world of work and specific jobs (Schaap, n.d.).

The PIBSpEEx proved to be effective in predicting academic success in the first year students it was administered to at Technikon Pretoria and, later, Tshwane University of Technology, where it was known as Potential Assessment (Potential Assessment: A

Historical Overview, n.d.). The PIBSpEEx allows scoring and interpretation of both specific abilities required and an overall total ability score. For example, if generic ability were to consist of verbal, numerical and spatial reasoning, a sub-scale ability score could be obtained for each along with sub-total and total abilities scores (Compindex: Psychometric Test, n.d.).

Between 1998 and 2003, Kriel and, later, Dockrat (cited in Potential Assessment: A Historical Overview, n.d.) conducted a series of validation studies using a Potential Index Batteries (PIB) and PIBSpEEx cognitive testing battery for selection purposes at Tshwane University of Technology (previously known as Technikon Pretoria). The PIBSpEEx accounted for the following levels of variance in academic performance on a specific course subject in National Diploma programmes.

Kriel's results (cited in Potential Assessment: A Historical Overview, n.d.) indicate that the PIBSpEEx generally accounts for high levels (between 60% and 90% in most cases) of variance in predicting academic performance across a wide variety of National Diploma courses. Academic performance, as a criterion, referred to the results of only one year-module or subject in the course. Therefore fluctuations in levels of variance predicted by the PIBSpEEx may have been affected by which academic subject was selected as the criterion. In addition, although the results are generally high, they do range quite dramatically (for example, 40% of variance was explained for Radiography students while 90% was explained for Analytical Chemistry). It is unknown whether this variation is a function of sample size, predictive power for specific types of courses, secondary education results or other factors. Further investigation would be required in order to understand the reasons for this range. The amount of variance predicted for certain courses differed from year to year, indicating that the sample, the assessment, or the criterion, were not stable over that time for unknown reasons.

The PIBSpEEx scales are intended to assess cognitive ability across various areas of 'learning potential' in a manner which is not reliant on any particular context or any prior skill acquisition. Erasmus (2004) originally conceptualised the PIBSpEEx to identify 'containers' of learning ability or potential in the cognitive domain. This theory was implemented in a large scale study at Technikon Pretoria (later, Tshwane University of Technology) where it was found that the predictive power of the PIBSpEEx in predicting a certain amount of academic success was fairly high and that further investigation and

validation of the instrument as a predictor of cognitive potential for the academic domain was warranted.

Rationale and Research Questions

After consideration of prior literature, it appears that a variety of selection and admissions policies, in relation to both Academic Points Scores and the use of cognitive instruments such as the PIBSpEEx should be considered. Needless to say, given the current state of higher education, and the potential entanglement of competencies and cognitive skills, regardless of assessment, a clearly defined and research selection process is required. Since cognitive skills and achievement in both Secondary and Tertiary education are partially co-dependent and reliant on a number of other extrinsic and intrinsic factors, a simple black and white exposition of guaranteed selection is impossible. However, the relationships between cognitive and achievement oriented selection facets are important to understand for fair and useful selection. Therefore, the following research questions were identified:

1. Do demographic differences exist in average mark, APS and PIBSpEEx results? This question will allow fuller understanding of potential discrimination or differential functioning of these constructs.
2. Does a relationship exist between APS and average mark (academic performance or pass/fail) for the two years of intake?
3. What relationships exist in terms of understanding the construction of the PIBSpEEx battery? More specifically, what relationships exist between the seven scales and Total score of the PIBSpEEx battery?
4. What relationship exists between the PIBSpEEx scales (including the Total score) and students' APS and average mark in each of the two years of intake?
5. Do specific PIBSpEEx scales contribute, or contribute differentially, over and above APS in predicting students' average marks?
6. To what degree do APS and the PIBSpEEx scales in some combination predict academic success in terms of average mark or binary pass/fail?

In order to understand these relationships and meet these aims, a variety of statistical methods were utilised. Since the purpose of the study was to understand predictive power better, it was essential to conduct a thorough analysis of the relationships between the instruments in order to fully understand individual and combined predictive validity. In addition, it is hoped, that

this will illuminate not only the current predictive power of the Secondary education system, but also the specific cognitive competencies inherent in the PIBSpEEx instrument which may contribute to prediction of Tertiary education average marks and success.

Chapter 3: Methods

Sample

The sample consisted of students who had written the PIBSpEEx for selection purposes at a University of Technology and students who had been accepted to a variety of National Diploma courses for which selection assessments were utilised. Please see 'Procedure' below for a comprehensive description of the data sets.

The original sample, consisting of archival data from the 2010 and 2011 intakes at a University of Technology, consisted of students who were: a) enrolled at the University of Technology; b) had written the PIBSpEEx but not been accepted or enrolled or; c) had both been accepted to the University of Technology and had written the PIBSpEEx. No demographic data was available for students who had written the PIBSpEEx but not been accepted to the university. Although information on Home Language and Gender are collected at time of writing, this information is not available in the output files utilised for data collection. Therefore, demographic data was only obtainable for groups a) and c) above. Data was only collected for specific courses which require the PIBSpEEx as part of the admissions requirements, either for all students or for students with APS scores within a specific (lower) range. Therefore, only certain courses with specific requirements are considered. As a result, APS score range was restricted (some courses only required the PIBSpEEx to be written for lower APS score 'brackets'). In addition, students with higher APS scores often were not required to write the PIBSpEEx prior to admission. This fact, combined with the non-acceptance of many students who did write the PIBSpEEx, resulted in missing segments of data throughout the data set (for example, APS and Average Marks were available but PIBSpEEx was not, or PIBSpEEx was available but APS and Average Marks were not). The following table provides information on the demographic data of the samples obtained.

Table 2:
Demographic information

2010				*2011*			
		n	*%*			*n*	*%*
Gender	Female	2286	54.40%	Gender	Female	2462	52.20%
	Male	1916	45.60%		Male	2257	47.80%
Ethnic Group	North Sotho	976	23.20%	Ethnic Group	North Sotho	1004	21.30%
	Tswana	559	13.30%		Tswana	641	13.60%
	African	469	11.20%		Zulu	520	11.00%
	Zulu	411	9.80%		Tsonga	474	10.00%
	Tsonga	393	9.40%		Swati	440	9.30%
	White	363	8.60%		White	373	7.90%
	Swati	252	6.00%		African	298	6.30%
	Ndebele	222	5.30%		Ndebele	259	5.50%
	South Sotho	183	4.40%		South Sotho	231	4.90%
	Venda	174	4.10%		Venda	184	3.90%
	Xhosa	139	3.30%		Xhosa	176	3.70%
	Coloured	35	0.80%		Pedi	67	1.40%
	Indian	17	0.40%		Coloured	38	0.80%
	Pedi	9	0.20%		Indian	14	0.30%
Language	North Sotho	1093	26.00%	Language	North Sotho	1069	22.70%
	Setswana	573	13.60%		Setswana	670	14.20%
	Zulu	466	11.10%		Zulu	595	12.60%
	Tsonga/ Sjangaan	359	8.50%		Swazi	456	9.70%
	Swazi	348	8.30%		Tsonga/ Sjangaan	345	7.30%
	Afrikaans	296	7.00%		Afrikaans	295	6.30%
	English	255	6.10%		South Sotho	262	5.60%
	Ndebele	201	4.80%		Ndebele	240	5.10%
	Venda	181	4.30%		English	229	4.90%
	South Sotho	180	4.30%		Venda	183	3.90%
	Xhosa	138	3.30%		Xhosa	174	3.70%
	Tsonga	54	1.30%		Tsonga	122	2.60%
	Afrikaans/ English	21	0.50%		Afrikaans/ English	31	0.70%
	French	20	0.50%		French	28	0.6%
	Other	17	0.40%		Other	20	0.4%
Residence	Off Campus	2890	68.80%	Residence	Off Campus	3112	65.90%
	Residency	1312	31.20%		Residency	1607	34.10%
Bursary	Bursary or Funding	2183	52.00%	Bursary	Bursary or Funding	2909	61.60%
	None	2019	48.00%		None	1810	38.40%

Table 3:
APS and average marks

	2010					*2011*			
	n	*Max*	*Min*	*Mean*		*n*	*Max*	*Min*	*Mean*
Age	4202	61	19	23	Age	4719	51	17	22
APS Score	4202	50	5	23	APS Score	4719	77	5	25

2010 Intake

The 2010 intake yielded a total sample of *n*=4202 cases. Of these, 54.4% were female. The majority stated their ethnicity as North Sotho (23.2%) with the next most common ethnic group being Tswana (13.3%) then Zulu (9.8%) followed by Tsonga (9.4%) with smaller percentages being allocated to the other groupings. A proportion of the sample self-designated their ethnic group simply as African (11.2%). Since this was a relatively large proportion, it was decided to keep this group separate for the purposes of analysis. The majority of the sample spoke either North Sotho (26.0%) or Setswana (13.6%) as their home language. Smaller proportions spoke Zulu (11.1%), Tsonga/Sjangaan (8.5%) or Swazi (8.3%) amongst other languages. During the first year of study (2010) 68.8% of the students were residing off campus while 31.2% were in residency at the university. In the same year of intake 52% of the sample were receiving some sort of bursary or funding including NSFAS (National Student Financial Aid Scheme) funding, external bursaries, institutional bursaries and other governmental funds. The average age reported in the 2010 intake was 23 years with the oldest being 61 and the youngest 19. In terms of APS scores the mean APS was 23.

2011 Intake

The 2011 intake consisted of *n*=4719 students for the selected courses in this study. Of these 52.5% were female and the majority (21.3%) were North Sotho. The next largest ethnic group was Tswana (13.6%) followed by Zulu (11.0%) and Swati (9.3%) with the remaining percentages being split around a number of other groupings. The most commonly spoken language was North Sotho (22.7%) followed by Setswana (14.2%) then Zulu (12.6%) and smaller percentages being allocated to other language groupings. In this case 65.9% of the sample resided off campus and 61.6% had obtained some sort of bursary or funding. This represents a fairly large increase from the 52.0% evidenced in the 2010 sample and it is unknown if this increase is due to sampling error or increased availability of NSFAS and other bursary funding. In the 2011 intake the youngest student reported an age of 17 and the oldest 51 with a mean age of 22. The mean APS score was recorded at 25, 2 points higher

than in the 2010 intake (this may be an artefact of small yearly increases in admissions requirements or due to actual changes in Grade 12 scores).

Instruments

PIBSpEEx Battery (Potential Assessment)

The PIBSpEEx Potential Assessment used at a University of Technology consists of 7 sub-scales chosen specifically for the context. All the scales consist of a forced choice format in which the respondent must choose from options A, B, C, D or E. Answers are marked on a separate answer sheet for the purposes of optical scanning. Each respondent fills in a biographical section prior to commencement of the assessment. Two scale types are utilised: cognitive English (verbal type reasoning and activities) and cognitive visual (non-verbal type reasoning and activities).

1. PIBSpEEx 100 (Conceptualisation). The conceptualisation scale is a cognitive visual scale. The scale items consist of a figure or symbol in the first (separate) row of 7 boxes. Respondents are required to examine the symbol in the seventh and final box of the row of which the first symbol forms an integral part. Respondents must then select which item in the intervening boxes (boxes 2 through 6) must be added to the first to form the figure or symbol found in the seventh. Three examples are explained by the administrator. The respondents are permitted 5 minutes to attempt the remaining 30 items.
2. PIBSpEEx 402 (Advanced Observance or Mental Alertness). PIBSpEEx 402 is a cognitive English scale. Respondents are required to select which of five words presented in a horizontal row is uniquely different from the others (i.e. which is the odd one out). The administrator explains two examples. Respondents are permitted 5 minutes to attempt 30 items.
3. PIBSpEEx 304 (Calculations – Advanced). The calculations scale is a cognitive English scale. This scale is intended only for those who have already obtained at least a Grade 12 qualification and is therefore suitable for applicants to tertiary education. Respondents are required to read a question requiring calculations consisting of either a word problem (e.g. R3,00 equals $1,00. I have R3000. How much do I have in dollars?) or of items combining calculation and sequencing of numerical material. The respondents are not given any examples nor are any of the items discussed with

respondents before and during the tests. If, once the test has begun, a respondent requires assistance then item 1 only may be used for explanatory purposes. The respondents are given a piece of paper to perform calculations on and have 15 minutes to attempt to answer 30 items.

4. PIBSpEEx 401 (Observance). The Observance scale is a cognitive visual scale. Respondents select which of five pictures, figures or symbols does not belong with the other four (i.e. which is the odd one out). The scale consists of 24 items of which 2 are used for example purposes. Respondents have a 5 minute time limit in which to attempt the remaining 22 questions.
5. PIBSpEEx 1600 (Reading Comprehension). The reading comprehension scale is a cognitive English scale. The scale consists of two parts: reading a passage and responding to questions about the passage read. Respondents are permitted 5 minutes to read a short passage. They are required to memorise the passage as well as they can within the time limit. Following the reading section, respondents are then permitted 6 minutes to answer forced choice questions about the content of the passage. During this time they are not permitted to turn back to the passage thus providing a score based on both reading comprehension and memory.
6. PIBSpEEx 1000 (Insight). The insight scale is a cognitive English scale. The scale comprises 13 riddles in English requiring the respondent to read a description of each riddle and find the correct explanation from five possible solutions. Respondents are required to grasp the riddle in its real or concrete meaning by using insight to unravel the abstraction and phrasing of the item. This scale deals with the abstract component of cerebral reasoning using both deduction and induction. In addition, the scale measures a basic sense of judgement in perceiving one's environment in terms of the logical essence of the idea. Two examples are presented to the respondents who then have 7 minutes to complete the remaining 13 items.
7. PIBSpEEx 502 (Assembling – Advanced). Assembling (Advanced) is a cognitive visual scale. This scale is comprised of a picture which has been broken down into its components, some of which have been rotated, and an 'answer sheet' on which respondents are required to 'build' the picture in empty blocks in which an assistive outline is provided. Respondents are still required to mark their answers on the separate answer sheet by selecting a letter (A-N) to go alongside each number (1-14) representing which piece of the picture they will place in each empty block. One example is presented which is a smaller version of the item used in the scale (three

pieces rather than fourteen). Respondents are permitted 2 minutes in order to build as much of the picture as possible.

Using multiple regression analysis on PIBSpEEx scales, validity coefficients were calculated for pre-selected students accepted into National Diploma programmes at a University of Technology implying a restricted range effect to persons who achieved higher scores on the assessment (Kriel, 2002). It is important to note that, in Kriel's (2002) research, the Potential Assessment battery was administered after acceptance into the institution and that three scales (Environmental Exposure, Comparisons and Perception) have now been excluded from the battery. Following the exclusion of the three redundant scales, several hypothetical summary scales were created: Verbal, consisting of Conceptualisation, Mental Alertness, Observance and Insight; Non-Verbal, consisting of Calculations and Object Assembly and; Language, consisting of Reading Comprehension.

Criterion validity coefficients for the instrument ranged between 0.34 and 0.68 all of which were significant at either the .05 or .01 level (Kriel, 2002) Anastasi and Urbina (1997) state that, to be acceptable, validity coefficients should be of a sufficient magnitude to be statistically significant in order to be sure that the coefficient's size is not a result of chance fluctuations and that even coefficients of 0.20 or 0.30 can be justified for inclusion in selection programs. However, note that Kriel's (2002) sample was not large (see Appendix 1).

Using the Kuder-Richardson formula, inter-item consistency reliability coefficients have been calculated only for a custom-scale used for the selection of Engineering Technology students, however many of the scales correspond to those currently used (Kriel, 2001). Kuder-Richardson was an applicable formula to use given that it is useful to tests whose items are scored either right or wrong on an all or nothing system, as those in the PIBSpEEx are (Anastasi & Urbina, 1997). The coefficients ranged from 0.68 to 0.87. According to Anastasi and Urbina (1997) coefficients falling within the 0.80 or 0.90 ranges are usually acceptable – therefore several of the coefficients calculated in this case are lower than is desirable. For this reason, an exploration of the inter-item consistency of the PIBSpEEx in the present study is desirable.

Academic Points Scores

Academic point scores are based on levels of achievement in Grade 12 subjects. The scores are based on the percentages achieved in specific subjects during final Grade 12 exams and

calculated as follows: Scores are added together for the highest six subjects taken (excluding Life Orientation) to provide a total APS. Candidates must have taken English as a language (home or 1st additional) and either Mathematics or Mathematical Literacy. Points are calculated as follows: 0%-29% = 1; 30%-39% = 2; 40%-49% = 3; 50%-59% = 4; 60%-69% = 5; 70%-79% = 6 80%-100% = 7.

Exam Results

Exam averages were calculated based on all subjects taken by the student as an average. Therefore, mid-year and end of year exam results comprised part of the average score. Exam papers are set and marked by the academic departments and lecturers concerned, under the control of the University of Technology. Marks are assigned and averages reflected as a grade out of 100 in the form of a percentage.

Procedure

Data Collection

Archival data was utilised, obtained from the University of Technology for specific courses which require the PIBSpEEx for entry either for all students or due to students' APS scores falling within specific ranges. Since the collected data was obtained from two different sources, the data was combined into one data set. The data obtained from the University of Technology included the following variables: Student and ID number; faculty enrolled in; course enrolled for; specific subject codes and marks; year of entry (intake); calendar year (year mark obtained for); average mark for calendar year (e.g. average for year 2011); overall average mark (all years enrolled); PIBSpEEx subtests (conceptualisation, mental alertness, observance, insight, calculations, object assembly and reading comprehension); cumulative scores for specific subtests (verbal reasoning consisting of the first four subtests, non-verbal reasoning consisting of the second two and a total score); APS score; age; gender; home language; ethnicity; whether or not living in residency; whether or not have obtained bursary or other funding such as NSFAS; home address (where available) and; secondary school name (where available). Not all this data was utilised during the current analyses but was kept on record for potential additional analyses as required. Due to very low frequencies of certain home language categories such as Spanish, French, Portuguese and Chichewa, these were combined into one 'Other' category for the purposes of analysis. Due to the large number of

ethnic groups reported, an additional variable was utilised in some analyses, dividing ethnicity into four categories: Black, White, Indian and Coloured.

For the purposes of this study, following the initial data collection and cleaning, a second data set was created which eliminated the repeat cases due to subject codes (i.e. each student number was repeated several times, once for each subject), maintaining only the average mark, average per year and APS variables from the University of Technology, as well as the demographic and PIBSpEEx (where available) variables. Removal of the repeats did not affect the results of the average mark per year or for all years as these were calculated correctly prior to removal of the subject marks. Due to an error inherent to the original data, some corrections had to be done on the PIBSpEEx subtest 'Reading Comprehension' in order to correct a small proportion of scores which had inadvertently been multiplied by 2 in the originally collected data. These scores only were divided by 2 to obtain the correct range (i.e. 1-10). In addition, a variable was created categorising cases as 'Pass' or 'Fail' with 'Pass' as an average of all marks (i.e. all marks from all years of study) that was greater than or equal to 50% and 'Fail' being an average less than 50%.

Due to the fact that only a portion of accepted students who wrote the assessment were accepted (some were not admitted) and not all students admitted had written the assessment, the data sets exhibited missing portions (as indicated earlier). This discrepancy arose since, dependent upon course requirements, only certain students with APS scores within specific (lower) brackets were required to write the assessment. In order to deal with this, multiple imputations (Rubin's) were utilised with 5 iterations in order to create an estimation of the missing data (PIBSpEEx scores for those who were admitted but did not write and academic marks for those who wrote the PIBSpEEx but were not admitted). Following the multiple imputation and use of inferential statistics, pooled results across the five imputations were utilised for the purposes of reporting results.

Data Analyses

Preliminary analyses.

In order to better understand the PIBSpEEx scale, Academic Points Scores and Average of All Marks, various analyses were conducted using IBM Statistical Product and Service Solutions (SPSS) version 22 (note: this program was utilised for all descriptive and inferential analyses unless otherwise specified). All descriptive analyses and the preliminary analyses of the instruments were conducted utilising the data set as a whole, and not

separated by year of intake as was done for the inferential analyses. Descriptive statistics and assessments of skewness and kurtosis were analysed for all the variables. In addition, the PIBSpEEx scale was further explored. A reliability analysis utilising Cronbach's Alpha was conducted on the PIBSpEEx Total Scale. A factor analysis was conducted on the PIBSpEEx scales in order to test a hypothetical grouping of scales (please see later in the Results section). This analysis was done with the Statistical Analysis System (SAS) utilising a covariance matrix in order to deal with the multiple imputation data set. Factors were extracted by the method of Principal Components utilising Varimax rotation for simplicity of interpretation (Ho, 2006). The Eigenvalues (factor loadings) produced were examined.

Differences between demographic groups.

Two different inferential statistics were utilised to assess differences between demographic variables on the outcome variables and the significance level was set at $\alpha=.05$ for all analyses (this applies for all analyses in this study). Independent samples T-Tests were used to examine differences in bivariate constructs (Gender, Residency and Bursary). The T-Test was chosen since it provides two statistics, one assuming equal variances and one if the assumption of equal variances is rejected (i.e. $p<.05$ for Levene's statistic (Ho, 2006)). In most cases, the assumption of normal distribution was met. Where Levene's statistic was significant ($p<.05$), the equal variances not assumed results were utilised (Ho, 2006).

In the case of multiple level demographic variables (Home Language and Ethnicity), one-way ANOVA (*F*) was used to examine possible differences between the groups. The assumption of homogeneity of variance was considered when calculating the ANOVA (Levene's Statistic). If this assumption was not met (i.e. Levene's statistic was significant), the Brown-Forsythe *F* was used as a more robust alternative statistic (Field, 2012). Since each IV (i.e. Home Language or Ethnicity) had only one level, interaction effects were not pertinent (Ho, 2006). Where significant results were achieved, Tukey's HSD was utilised for *post-hoc* analyses. Pearson's *r* was used to examine potential linear relationships between age and the outcome variables with R^2 being utilised as a measure of effect size.

Cohen's *d* was calculated as a measure of effect size to better understand group differences and relationships where independent sample T-Tests were used. Effect size essentially refers to a standard measurement of the magnitude and importance of the observed effect or difference (e.g. between means) rather than focusing only on whether the difference is statistically significant (i.e. probability) (Field, 2005). Cohen's *d* considers effect size in

terms of the differences between means ($M_1 - M_2$) pooled standard deviation (σ_{POOLED}) yielding the following formula (Cohen, 1988):

$$d = \frac{M_{GROUP1} - M_{GROUP2}}{SD_{POOLED}}$$

$$\text{Where: } SD_{POOLED} = \sqrt{\frac{(SD^2_{GROUP1} + SD^2_{GROUP2})}{2}}$$

The effect sizes were tentatively defined as follows: Small (0.0-0.2), medium (0.3-0.5) and large (0.6-2.0) (Wuensch, 2009). As such, small effect sizes may indicate a difference in the population as reflected by the sample, but this difference is not easily observable, despite the possibility of it being statistically significant. A large effect size indicates large differences in real terms (even if the sample demonstrates an apparently small difference in means) (Walker, 2007).

Where analysis of variance was utilised, partial η^2 was used as a measure of effect size and explanation of percentage of variance. Partial η^2 refers to the ratio of variance accounted for by an effect plus the associated error variance (Brown, 2008). Results are multiplied by 100 in order to provide a percentage of variance explained by each of the effects and associated error. If the analysis is a one-way analysis of variance, no difference exists in the results of partial η^2 and η^2, therefore, either can be utilised (Brown, 2008). The formula for partial η^2 was as follows (Brown, 2008):

$$\eta^2_{PARTIAL} = \frac{SS_{effect}}{SS_{effect} + SS_{error}}$$

Where: SS_{effect} is the sum of squares for the effect of interest and;
SS_{error} is the sum of squares for error term associated with the effect of interest

Following calculation of the effect size, approximate *PS* or probability of superiority values were noted to provide an indication of the percentage of the time a randomly sampled member of the population with the higher mean would score higher than a randomly sampled member of the population with the lower mean (Fritz, Morris, & Richler, 2012).

Relationships between variables.

Correlation coefficients were conducted utilising Pearson's *r*. Relationships were examined between the Log10 transformed version of APS, each of the PIBSpEEx scales and the average of all marks. In addition, R^2 was noted as a measure of effect size in order to ascertain percentages of variance accounted for in the relationship.

Prediction of average mark: Regression, multiple regression and stepwise regression.

In order to better understand the predictive power of the independent variables, multiple regression was utilised. Initially, using the average of all marks as the dependent variable, two models were created: 1) APS (Log10 transformed) in combination with PIBSpEEx Total score in a multiple regression model; 2) The 7 PIBSpEEx scales in combination in a multiple regression model. Following this, a series of multiple regression models were created for the purposes of selecting the strongest PIBSpEEx scales as predictors (see later). Statistics were examined including Pearson's *r*, the coefficient of determination (R^2) and the significance of the model as a whole. Statistics indicating the relative strength (standardised β weights) of predictors and the significance of each predictor (*t* values and *p* values) were considered. Multiple regressions were conducted on the PIBSpEEx scales (as a single model consisting of the 7 scales as predictors) as well as the PIBSpEEx Total Scale in combination with APS (as a single model).

A series of two independent variable regression models were created in order to identify stronger predictors. Initially, for the PIBSpEEx only model, the strongest correlate was utilised as the initial predictor and each scale was added in separate regression models, creating six separate models consisting of two predictors. The change in R^2 statistic for each model was examined, in order to determine which model explained the most variance, thereby indicating the strongest additional predictors. The scales with the most additional variance explained were utilised in the stepwise regression model. The same process was followed utilising APS as the initial variable and identifying additional PIBSpEEx scales which contributed to variance explained.

For the PIBSpEEx scales alone, each scale was entered in priority order of strength, based on the previous multiple regression analysis. Where APS was utilised, it was assumed that, based on current selection procedures, this ought to be the strongest predictor and was therefore entered first, followed by the individual PIBSpEEx scales in the previously defined order. Several stepwise regression models were created (for the 2010 and 2011 intakes separately) utilising a) the three best PIBSpEEx scale predictors in combination and b) APS along with the previously selected PIBSpEEx scales. Statistics such as general model fit (*F*) and change statistics including R^2, R^2 change with each predictor entered, *F* (model) change and significance of change were considered along with the standardised regression coefficients (β) and their significance in the full model.

Prediction of pass/fail: Logistic regression.

In order to better understand the dynamics within the data, logistic regression was conducted using the binary pass/fail variable (pass being ≥50% average and fail being <50% average) in order to assess likelihood to pass based either on group membership or increases in a scale predictor variable. In this case, the information of interest was a better understanding of the relative likelihood to pass, given increases in the independent variables (APS and PIBSpEEx Total Scale). Here the original APS scale was utilised since logistic regression can better handle continuous variables which do not meet the requirement of normal distribution (Ho, 2006; Burns & Burns, 2009). Several logistic regression models were created in order to better understand the following: Demographic differences in likelihood to pass, APS as a predictor of likelihood to pass, specific PIBSpEEx scales (individually) as predictors of likelihood to pass, the Total PIBSpEEx scale as a predictor of likelihood to pass. Following the logistic regression the following statistics were considered: χ^2 and significance as an indicator of goodness-of-fit of the model, the Wald statistic as an indicator of the significance of the individual predictor, Exp(B) as an indication of odds of passing (where 0 was coded as fail and 1 was coded as pass) and the percentage of likelihood to pass increase (based on the Exp(B) value). For the logistic regression, separate models were created for each predictor variable individually (as opposed to the multiple regression models which examined predictors in combination). Consideration of multiple predictor variables in combination (for example, the PIBSpEEx scales in combination) to assess change in the model following deletion of weaker predictors was not possible since the multiple imputation data set eliminated different variables per imputation without providing a pooled result.

Chapter 4: Results

Preliminary Analyses of Instruments

The 2010 and 2011 intakes were analysed separately for the purposes of inferential statistics to better understand potential differences due to year of intake given changing secondary educational standards or other factors.

The PIBSpEEx

Descriptive statistics and normality tests.

A preliminary analysis of the PIBSpEEx scales yielded the following values utilising the pooled results. Please see Appendix 2 for a full table of descriptive statistics. Each scale is scored with a possible minimum score of 1 and a possible maximum score of 10. The Total Scale is the cumulation of the 7 scales and is therefore scored with a possible range of 7 to 70.

Conceptualisation scale.

The Conceptualisation scale produced a minimum score of 1.020 in 2010 with a maximum of 9.600. The mean score was 5.008. Statistics of skewness and kurtosis were within normal bounds (-1.000 to +1.000) being 0.061 and -0.107 respectively. In 2011 the minimum score was 1.000 and the maximum was 10.000. The mean score was 4.997. Statistics for skewness (0.070) and kurtosis (-0.115) were within the normal range.

Mental Alertness scale.

The Mental Alertness scale produced a minimum pooled value of 1.000 and a maximum pooled value of 9.300 in 2010. The mean score in that year of intake was 4.333. Statistics of skewness and kurtosis were within the normal range being 0.115 and -0.170 respectively. In 2011, similar descriptive were observed with the minimum value being 1.000 and the maximum being 9.220 with a mean score of 4.352. For the 2011 intake, the values for skewness (0.071) and kurtosis (-0.235) were also within normal range.

Observance scale.

For the 2010 intake, the minimum score for the Observance scale was 2.540 while the maximum score produced by the pooled data was 9.640. The mean score for that year of intake was 6.201. Tests of skewness and kurtosis revealed scores that were within the acceptable range being 0.010 and 0.031 respectively. In the 2011 intake, the minimum score was 1.000 while the maximum pooled score was 10.000. The pooled mean for that year of

intake was 6.148 and statistics of skewness (-0.135) were within the normal bounds as was the kurtosis statistic (0.762).

Insight scale.

The Insight scale produced a minimum score of 1.000 and maximum score of 9.460 with a mean of 4.153 for the 2010 intake. In that year, statistics of skewness (0.212) and kurtosis (-0.264) were within the acceptable limits. In the 2011 intake, a minimum score of 1.000 and maximum of 10.000 with a mean of 4.251 was produced. Statistics of skewness and kurtosis were within normal bounds being 0.490 and 0.387 respectively.

Calculations scale.

For the 2010 intake, the Calculations scale provided a minimum score of 1.000 with a maximum score of 6.920 and a mean of 3.200. Tests of skewness and kurtosis produced values within the normal range being 0.228 and -0.205 respectively. Similar results were produced for the 2011 intake with a minimum score of 1.000, a maximum score of 8.000 and a mean score of 3.173. Tests of skewness and kurtosis were within normal bounds providing statistics of 0.235 and -0.028 respectively.

Object Assembly scale.

The Object Assembly scale produced a minimum pooled value of 1.000 for the 2010 intake with a maximum value of 10.000 and a mean of 4.454. Tests of skewness and kurtosis produced statistics of 0.356 and -0.441 respectively, within normal limits. In the 2011 year of entry, a minimum and maximum of 1.000 and 10.000 were produced. The mean pooled score was 4.398. Tests of skewness (0.360) and kurtosis (-0.445) were within normal limits.

Reading Comprehension scale.

The Reading Comprehension scale provided a minimum of 1.000, a maximum of 9.900 and a mean score of 4.628 for the 2010 year of entry. In that year of entry the tests of skewness and kurtosis produced statistics which were within normal limits being 0.156 and -0.254 respectively. For the 2011 intake, the minimum score produced by the pooled result was 1.000 and the maximum was 9.900. A mean score of 4.640 was produced. Tests of skewness (0.123) and kurtosis (-0.286) produced statistics which were within normal limits.

Total PIBSpEEx Scale.

The Total scale is produced through cumulation of the seven subscales into a total score. For the 2010 intake, the minimum score produced was 21.000 and the maximum was 42.000. The

mean score was 33.517. Tests of skewness and kurtosis were within normal ranges being -0.541 and -0.369 respectively. For the 2011 intake, the minimum score was 12.000 and the maximum 53.000 with a mean of 33.114. Tests of skewness (0.150) and kurtosis (-0.099) were within normal limits.

Reliability analyses.

When utilising the data for selection purposes, the scores are cumulated into three subtest scores as well as a total. These consisted of Verbal Reasoning (Conceptualisation, Mental Alertness, Observance, Insight), Non-Verbal Reasoning (Calculations, Object Assembly) and Language (Reading Comprehension) as well as a cumulative Total Scale (Total score). A reliability analysis of the Total Scale was conducted utilising Cronbach's Alpha. Since the Language Scale consisted of only one scale (Reading Comprehension), and the Verbal and Non-Verbal Scales consisted only of four and two scales respectively, useful reliability values could not be conducted. Utilising a pooled result, the seven scales comprising the Total scale produced a Cronbach's Alpha value of α=.697 in the 2010 intake. In the 2011 intake, the Cronbach's Alpha value produced was α= .733. Although acceptable, these values could, preferably, be somewhat higher (α>.800) (Anastasi & Urbina, 1997). No scale deletions would cause the Cronbach's Alpha value to increase for the Total scale. The Item-Total correlations were similar across all seven scales, indicating that no particular scale appears to be insignificant or over-contributing to the Total scale.

Factor analysis.

In order to test the assumption that the scales divided into Verbal, Non-Verbal and Language cumulative scales, factor analyses were conducted. Due to the multiple imputations, a covariance matrix of the data was utilised for the factor analysis. This analysis was repeated set to extract the supposed three factors with Varimax rotation by the method of Principal Components. Since rotation is intended to facilitate interpretation of prominent factors following initial extraction (Abdi, 2003) examination of the Varimax rotated component matrix was utilised following a specification to extract three factors. This result is likely to be easier to interpret, more reliable and more replicable (Abdi, 2003). The Varimax rotation is an orthogonal (axes at 90 degrees to one another) rotation and should, ideally, provide a simple solution in terms of a small number of large loadings and a large number of zero or very small loadings thereby allowing each factor to be associated with a small number of variables. The opposition of few variables with positive loadings to a few with negative loadings on certain factors may also occur (Kaiser in Abdi, 2003). To achieve this outcome,

the Varimax rotation algorithm selects the rotation for which the variance of the loadings is maximised (Abdi, 2003). It is important to note that due to the presence of only seven scales, the factor analysis results are likely to produce fewer factors.

The loadings and variances explained by the rotated model, although low, did provide some interesting insights. The following table (Table 4) shows the factor loadings where three factors were extracted using Varimax rotation.

Table 4:
Factor loadings of the PIBSpEEx scales following Varimax rotation

	Factor 1	*Factor 2*	*Factor 3*
Conceptualisation	0.360	0.635	0.281
Mental Alertness	0.554	0.380	0.176
Observance	0.136	0.160	0.958
Insight	0.741	-0.005	0.190
Calculations	0.625	0.263	0.049
Object Assembly	0.112	0.892	0.045
Reading Comprehension	0.693	0.180	0.010

These results did not confirm the hypothetical three factors initially postulated in use of the PIBSpEEx scales. The majority of scales loaded on Factor 1 (Mental Alertness, Insight, Calculations and Reading Comprehension). Conceptualisation and Object Assembly both loaded on Factor 2. Only Observance loaded to Factor 3. It is important to note that the Eigenvalues produced are rather low, well below the usual threshold of 1.000. When considering these tentative loadings, it appears that scales strongly loaded on English language loaded to Factor 1. Non-verbal or spatial reasoning scales appeared to load to Factor 2. The Observance scale appears to be unique with few commonalities with the other scales. Since the factor analysis failed to confirm the hypothetical Verbal, Non-verbal and Language sub-total scale distinction, only the Total scale was utilised for later analyses.

APS Scores

Descriptive statistics and normality.

Some differences were observed between the 2010 and 2011 imputed data sets in terms of APS scores. The following table of descriptive statistics was obtained for the pooled results. Some APS scores are below the hypothetical level of entry for National Diploma courses but were present in the data obtained from institutional records.

Table 5:
Descriptive statistics: APS scores

Year of Entry	*Min*	*Max*	*Mean*	*SD*
2010	5	50	23.25	4.932
2011	5	77	25.17	5.411

For the 2010 year of entry, the statistic for skewness was 0.135, well within acceptable limits. However, the kurtosis statistic was 1.236, just outside the generally accepted level. In 2011, these values jumped to 1.257 and 4.432 respectively. Although the reasons for this are unclear, it would appear that in the 2011 intake APS scores became increasingly clustered around the lower end of the possible range. This may have been due to error, some sort of change in data accuracy or completeness, some change in entry requirements or changes secondary education issues. This was confirmed by examination of frequency tables and graphic representations. However, the maximum score in 2011 was some 27 points higher than that exhibited for this data in 2010, potentially indicating a wider range of scores in that year or the presence of outliers. This may have affected the skewness statistic by introducing a number of outliers in a few cases which can impact the shape of the distribution. When the data was examined more closely, with the aid of frequency tables and graphic representations, in both years the majority of cases fell between scores of 20 and 28 with relatively few cases outside this range. Following a Log10 transformation of the APS variables, the skewness statistic fell within, or close to, normal range: -1.029 (2010); -0.098 (2011) and; -0.314 (combined intakes). However, the kurtosis statistic remained outside of the normal range: 3.030 (2010) and; 3.102 (2011). The higher value of kurtosis somewhat confirms the aforementioned supposition, potentially indicating that most scores were clustered around a central point with smaller numbers at the tail ends of the distribution. Due to the correction of skewness following the Log10 transformation, the transformed variable for APS was utilised for the inferential analyses and comparisons.

Abnormal statistics for kurtosis were expected in this distribution due to limitations on entry requirements which, concomitantly, imposed limitations and impacted likelihood of certain scores during the imputation process. The resultant distribution reflected only a segment of the population who met the minimum entry requirements but also, quite often, fell within a limited bracket of APS scores which, particularly in the Management faculties, excluded them from attending Academic Universities with higher entry requirements. As a result, the distribution was truncated at the lower end due to entry requirements and thinned at the upper end, possibly due to preference for Academic Universities if the entry

requirements were met. The distribution is therefore peaked and skewed towards the upper values. This may be partially due to the nature of a University of Technology and the students it is likely to attract, and partially due to limitations (particularly lower limitations) imposed by the clustering of APS scores nearer the lower end of the spectrum, these findings are not particularly surprising.

Academic Results (Average Of All Marks Obtained)

Descriptive statistics and normality.

The academic results considered here are the cumulative averages across all years of study the student has been registered as well as all modules/subjects, regardless of whether or not the student passed. The descriptive statistics produced here apply to the pooled results (Table 6):

Table 6:
Descriptive statistics: Average mark

Year of Entry	*Min*	*Max*	*Mean*	*SD*	*Skewness*	*Kurtosis*
2010	2.400	93.111	53.715	11.133	-0.543	2.030
2011	2.500	95.667	54.562	10.933	-0.622	2.094

When considering the skewness and kurtosis of these distributions, some interesting points emerge. Statistics of skewness were fairly close the 0 while those for kurtosis were outside of normal bounds in the positive direction. This is a similar pattern to that evidenced by the APS distribution, with kurtosis being fairly strongly positive. However, this type of distribution was to be expected (to a certain extent) since it was intuitively probable that the majority of students would fall within the 'average' grades of 40%-60% within the distribution. A closer examination of scatter graphs demonstrated this to be the case.

Demographic differences in the dependent variables

Demographic Differences And APS Scores

Independent samples T-Tests.

Independent samples T-Tests were conducted on Gender, Bursary status and Residency utilising the Log10 transformed APS variable as the dependent variable. In addition, Cohen's *d* was calculated. The pooled result was utilised in the multiple imputation data. The results for 2010 and 2011 intakes are presented in the following table (Table 7):

Table 7:
Independent samples T-Test and effect size results between demographics and Transformed APS scores

Intake		*d.f.*	*T*	*P*	*M difference*	*Category of higher mean*	*d*	*d Size class*	*Approx. PS*
2010	Gender	3897	-1.734	.083	0.208	Male	0.06	Small	52
	Bursary	3676	-13.288	.000**	2.094	Bursary	0.43	Medium	62
	Residency	3111	-8.879	.000**	1.194	Residence	0.29	Medium	58
2011	Gender	4542	2.346	.019*	.356	Female	0.07	Small	52
	Bursary	3076	-5.950	.000**	.838	Bursary	0.19	Small	55
	Residency	4029	-1.883	.060	0.012	Residence	0.06	Small	52

Note: *The mean difference is computed by the non-transformed scores while the effect sizes are computed using the transformed variable*
**Significant at the .05 level*
***Significant at the .01 level*

From the data it is clear that although some results were highly significant, the effect sizes were generally small. This seems to indicate that significance may have been achieved either as a product of sampling error or due to large sample sizes. The two effect sizes of interest were in relation to bursary and residence status in 2010 only. These produced medium effect sizes indicating that, in that year, students with higher APS scores may have been more likely to be provided with bursaries or other funding and to be accepted into residency. The PS (probability of superiority) values calculated indicated that in approximately 62% of cases those APS scores above the mean would be likely to have a bursary or other funding. In approximately 58% of cases they were likely to be in residency. A variety of reasons may exist for this including better preparedness of students with higher APS scores (early application for bursary, funding or residence).

One-Way Analysis of Variance.

One-way Analysis of Variance (ANOVA) was used to examine differences between the ethnicity and home language groupings. Since Levene's statistic reached significance (p<.05) in all cases, the Brown-Forsythe F was utilised as an alternative (see 'Methods'). The results were as follows:

Table 8:
One way analysis of variance: Demographics in relation to APS

Intake		*d.f.1*	*d.f.2*	*F*	*p*	*Partial* η^2	*% of variance*	*Approx. PS*
2010	Ethnicity	13	372	10.988	.000**	.039	3.9	61
	Home Language	14	62	6.932	.000**	.035	3.5	60
2011	Ethnicity	13	628	21.429	.000**	.068	6.8	65
	Home Language	14	253	15.507	.000**	.062	6.2	64

**Significant at the .05 level*
***Significant at the .01 level*

As noted in the results table, all interactions for all intakes proved significant. Tukey's HSD *post hoc* test was utilised in order to understand where the significant interactions were occurring. In the 2010 intake, the significant difference (p<.01) for ethnicity was between the White group and the African, Coloured, Ndebele, North Sotho, South Sotho, Swati, Tsonga, Tswana, Venda, Xhosa and Zulu groupings with the White group presenting means of 3 or greater higher than the other groups (according to the untransformed variable). No other significant differences were found for the 2010 intake with generally strong correlations (p<.700) with a few exceptions which were, nevertheless, non-significant. Similar results were found in the 2011 intake.

For Home Language significant differences were found for the 2010 intake between the Afrikaans and Afrikaans/English groups in comparison to all other language groups. These groups scored significantly better (p<.05) in terms of APS than the English only, Ndebele, North Sotho, Setswana, South Sotho, Swazi, Tsonga (not in comparison to Afrikaans/English), Tsonga/Sjangaan, Venda, Xhosa and Zulu groups but did not differ significantly from one another. No other significant differences were found. For the 2011 intake data, however, although the results remained the same for the Afrikaans group, the significance levels in the Afrikaans/English group comparison disappeared, with the exception of Venda (p<.05) where Afrikaans/English speakers scored more highly.

Despite significant differences, effect size results seem to indicate that less than 10% of the observed variance in APS score is accounted for by ethnic group or language. Therefore, it appears that although significant results were achieved, the differences observed were not of a particularly large magnitude.

Correlations.

Pearson's r was calculated between age and APS score (Log10 transformed to address skewness). This produced significant results for the 2010 intake (r=-.461, p<.01) and the

2011 intake (r=-.387, p<.01). Interestingly, it appears from this relationship that young persons demonstrated higher APS scores than older persons. A variety of reasons may exist for this including alteration of secondary schooling marking policies and standards, increases in tertiary institution requirements and recency of study including the advent of new curricula in the late 2000's. An examination of R^2 indicates that between 14.9% and 21% of variance in the variable APS score is explained by the variable age. The effect sizes are classified as medium (9%-25%) according to Cohen's (1988) classifications system (Fritz, Morris, & Richler, 2012), and are therefore worth taking note of. Therefore, approximate *PS* values of between 71 and 76 were provided. These results are both statistically and, potentially, practically significant.

Demographic Differences In PIBSpEEx Results

Independent samples T-Tests.

Independent samples T-Tests were conducted to examine differences between the binary demographic variables in terms of PIBSpEEx scores utilising the pooled results obtained from the multiple imputation data set. The tests revealed that there were no significant differences (p>.05) for any of the PIBSpEEx scales in terms of gender, residence on or off campus or bursary status (for a full table of results, significance, effect sizes and PS values please see Appendix 3). Cohen's *d* effect size was calculated yielding 'small' values with PS values of around the 50% (equal chance) mark. Therefore, it can be concluded, that none of the three demographic variables considered here demonstrated any differences in PIBSpEEx results obtained.

One-way Analysis of Variance.

One-way analyses of variance were conducted on Ethnicity and Home Language (please see Appendix 4). The usual ANOVA *F*-test was utilised and only where Levene's test produced a significant result (p<.05) was the Brown-Forsythe *F* was utilised as a substitute. For the 2010 intake, no significant differences were found (p>.05) between the different language groups on any of the PIBSpEEx scales. However, in the 2011 intake, some significant results were present. Significant differences (p<.05) were found between language groups for all the PIBSpEEx scales, including the cumulative total scale, with the exception of the Reading Comprehension scale. An examination of Tukey's HSD *post-hoc* assessment revealed that, similarly to other analyses, the primary difference lay in the Afrikaans and Afrikaans/English groups performing better on the assessments than the other language groupings.

An analysis of differences between ethnic groups produced no significant (p>.05) results for the 2010 intake. For the 2011 intake, statistically significant results were produced (p<.01) on all 7 PIBSpEEx scales and the Total scale. Examinations of Tukey's HSD *post-hoc* assessment revealed that the differences lay between the 'White' group and all other ethnic groups with the exception of the Indian and Coloured groups (note: these groups contained small sample sizes). It is of interest that the differences appeared in the 2011 but not the 2010 intake. Reasons for this are unclear but may be associated with changes in the schooling curriculum, influxes of students who previously could not (or would not) have applied or random error.

Upon examination of effect sizes (partial η^2) for the significant results in the 2011 intake, it was found that no interaction's effect size exceeded $\eta^2_{PARTIAL}$=0.017, equivalent to a PS value of approximately 57. A maximum of 1.7% of variance in the PIBSpEEx scales (or less for many of the scales) is explained by differences in demographic groupings.

Correlations.

Pearson's *r* was calculated between Age and each of the PIBSpEEx scales. The 2010 intake produced a significant (p<.05) Pearson's *r* of *r*=.013, *p*=.046. In the 2011 intake, a similar result was found where *r*=-.012, *p*=.030. Although these correlations are significant, the *r* values are very close to zero. An examination of the coefficient of determination (R^2) indicated that only a very small percentage (<.001) of variance in the PIBSpEEx total scale was explained by age. Therefore, it is unlikely that age has any bearing on performance in the PIBSpEEx.

Demographic Differences In Average Marks

Independent samples T-Tests.

Independent samples T-Tests were conducted to assess differences between binary demographic groups (Gender, Bursary/Funding status and Residency status) in terms of average marks. In both the 2010 intake and the 2011 intake, females significantly outperformed males (p<.01). However, an examination of effect size demonstrated that although this difference was significantly different only around 1% of variance was explained. Bursary holders scored significantly higher than non-bursary holders (p<.01) in both 2010 and in 2011. An examination of Cohen's *d* indicated that a medium effect size was produced, explaining between 1% and 5% of variance. However, although the effect size was classified as 'medium', the actual value fell closer to the 'small' range. In both 2010 and

2011, the mean scores of students in residency were higher by over 3.5%, a statistically significant difference (p<.01). The value of Cohen's *d* indicated that a medium, tending towards small, effect size was produced, explaining between 1% and around 4% of variance. Although these results demonstrated statistical significance, and note-worthy effect sizes and PS values, it is difficult to conclude that any practically significant difference exists. Table 9 summarises the results obtained:

Table 9:
Independent samples T-Tests of demographic differences in average mark

Intake		*d.f.*	*t*	*p*	*M difference*	*Category of higher mean*	*d*	*d Size class*	*Approx. PS*
2010	Gender		4.913	.000**	1.746	Female	0.158	Small	54
	Bursary		-14.370	.000**	4.977	Bursary	0.458	Medium	62
	Residency		-10.538	.000**	3.620	Residency	0.342	Medium	59
2011	Gender		4.071	.000**	1.327	Female	0.158	Small	54
	Bursary		-12.051	.000**	4.051	Bursary	0.373	Medium	60
	Residency		-13.084	.000**	4.043	Residency	0.391	Medium	60

**Significant at the .05 level*
***Significant at the .01 level*

One-way Analysis of Variance.

One-way Analysis of Variance was conducted to establish differences in average mark between Language groups and Ethnic groups. Since Levene's statistic was at the significant level (p<.05) for all analyses, the Brown-Forsythe *F* was utilised. Results for the 2010 indicated that significant differences (p<.01) existed between ethnic groupings in both the 2010 and 2011 intakes. *Post-hoc* analyses (Tukey's HSD) indicated that the differences lay between the White group and all other ethnic groups with the exception of Coloured, Indian and Pedi groups (p<.01). It is important to note that these three groups consisted of a considerably smaller sample than other groups in the analysis (please see the sample description for more details). The mean scores (percentages) for the White group were 6 or more points higher. In the 2011 intake, similar results were observed with the exception that a significant difference (p<.01) was now demonstrated between the White and Coloured groups, while the significant difference between the White and South Sotho had become non-significant (p>.05). In addition, the difference between the White and Ndebele groups was no longer significant at the 1% level but was now significant at the 5% level.

Significant differences were found between language groupings (p<.05) for both the 2010 and 2011 intakes. The primary significant differences in the 2010 intake were associated with the Afrikaans group. This group demonstrated significantly higher means

than almost all other groups (p<.01) except French (low frequency) and other (low frequency). No significant difference was found between the Afrikaans and Afrikaans/English groups or between the Afrikaans/English groups and any other language groupings. The English group demonstrated a significantly higher mean (p<.05) than the North Sotho, Tswana, Swazi, Tsonga/Sjangaan and Xhosa groups, but scored significantly lower than the Afrikaans group. In the 2011 intake, several of the significant results fell away but significant differences (p<.05) were observed between Afrikaans and North Sotho, Setswana, Swazi, Tsonga, Venda, Xhosa and Zulu groups, with Afrikaans students demonstrating a higher mean 'average mark'. English students also outperformed Swazi students, as did North Sotho speakers, South Sotho speakers and Tsonga/Sjangaan speakers (p<.05). Although multiple significant results were obtained, effect sizes produced indicated that less than 4% of variance in average mark was explained by group membership in the case of Ethnicity or Home Language in either intake. When the results were examined, consistent differences were found in two areas: White students vs. other ethnic groups and Afrikaans students vs. other language groups. An examination of frequencies indicated that the majority of White students had Afrikaans as a home language (76.3% in 2010 and 74.8% in 2011) with a minority indicating Afrikaans/English (5.2% in 2010 and 6.2% in 2011)) or English (18.5%in 2010 and 16.9% in 2011) as their home language. Table 10 demonstrates the results, effect sizes and approximate PS values associated with differences in average marks between ethnic groups and language groups.

Table 10:
One-way Analysis of Variance utilising the Brown-Forsythe F and effect sizes

Intake		*F*	*p*	*Partial* η^2	*% of variance*	*Approx. PS*
2010	Ethnicity	10.388	.000**	.038	3.8	61
	Home Language	9.734	.000**	.035	3.5	60
2011	Ethnicity	6.502	.000**	.020	2.0	58
	Home Language	3.894	.000**	.014	1.4	57

**Significant at the .05 level*
***Significant at the .01 level*

Correlations.

When considering the relationship between age and average of all marks, significant correlations were found in 2010 (r=.038, p=.000) and 2011 (r=.024, p=.000). As for the PIBSpEEx correlations, although significant results were achieved, the R^2 values indicate very little actual effect. As such, less than 1% of variance is explained. Therefore, it seems

fair to conclude that, despite statistical significance, age is unlikely to have any real impact on marks during National Diploma study in this sample.

Relationships between APS, PIBSpEEx Scales and Average of All Years

Relationships (Pearson's *r*) were examined between APS (utilising the Log10 transformed variable), the PIBSpEEx scales and the average mark obtained over all marks for all years of study. The pooled result from the multiple imputation data was utilised. The following correlation matrices were produced per year of intake:

Table 11:
Correlation matrix: APS Log10 Transformed variable, PIBSpEEx Scales and Average of All Marks obtained for the 2010 intake

2010 Intake	APS Log10 Transformed	Conceptualisation	Mental Alertness	Observance	Insight	Calculations	Object Assembly	Reading Comprehension	PIBSpEEx Total	Average of All Marks
APS_Log10	1									
Conceptualisation	.006	1								
Mental Alertness	.002	.379**	1							
Observance	.012	.318**	.232**	1						
Insight	.014	.286**	.308**	.203**	1					
Calculations	.020	.338**	.305**	.196**	.264**	1				
Object Assembly	.006	.375**	.281**	.212**	.193**	.219**	1			
Reading Comprehension	.005	.277**	.290**	.182**	.262**	.267**	.223**	1		
PIBSpEEx Total	.014	.688**	.646**	.492**	.598**	.557**	.650**	.609**	1	
Average of All Marks	.172**	.084**	.065*	.090*	.105*	.042	.061	.074*	.122**	1

**Significant at the .05 level (two-tailed)*
***Significant at the .01 level (two-tailed)*

Table 12:
Correlation matrix: APS Log10 Transformed variable, PIBSpEEx Scales and Average of All Marks obtained for the 2011 intake

2011	APS_Log10	Conceptualisation	Mental Alertness	Observance	Insight	Calculations	Object Assembly	Reading Comprehension	PIBSpEEx Total	Average of All Marks
APS_Log10	1									
Conceptualisation	.123**	1								
Mental Alertness	.127**	.396**	1							
Observance	.107**	.316**	.264**	1						
Insight	.146**	.318**	.332**	.228**	1					
Calculations	.107**	.358**	.315**	.206**	.281**	1				
Object Assembly	.125**	.387**	.292**	.212**	.241**	.245**	1			
Reading Comprehension	.111**	.306**	.323**	.207**	.294**	.293**	.258**	1		
PIBSpEEx Total	.194**	.695**	.656**	.500**	.631**	.569**	.665**	.631**	1	
Average of All Marks	.193**	.081*	.075*	.109**	.105*	.044*	.059	.087*	.126**	1

** Significant at the .05 level (two-tailed)*
***Significant at the .01 level (two-tailed)*

An examination of the 2010 intake results in comparison to the 2011 intake results indicates a shift from non-significant ($p>.05$) to significance ($p<.05$) in a large number of the correlations. Although the reasons for this are currently unknown, sample size prior to multiple imputation, shift in real sample size (see sample description) or real differences may be the cause.

For the 2010 intake, the results demonstrated a variety of significant correlations ($p<.01$) between the PIBSpEEx scales and the PIBSpEEx Total scale. Generally, these values were between $r=.492$ and $r=.688$. The Conceptualisation scale provided the strongest correlation, along with Object Assembly, Reading Comprehension and Mental Alertness. However, this may well be the result of random fluctuations rather than real changes.. In the 2010 intake, APS (utilising the Log10 transformed variable) correlated poorly ($r<.10$, $p>.05$) with the PIBSpEEx scales and Total scale. However, APS did correlate significantly with average mark ($r=.172$, $p<.01$). However, an examination of the coefficient of determination ($R^2=.030$) indicates that only around 3% of the variance in average mark was attributable to APS score.

The PIBSpEEx total correlated significantly with average of all marks (r=.122, p<.01). Again, examination of the coefficient of determination (R^2=.015) indicated that only about 1.5% of variance in average mark was attributable to the PIBSpEEx. This result, despite achieving statistical significance, does not appear to hold much practical significance. Correlations with the individual PIBSpEEx scales were generally unimpressive (r<.100) although some did achieve significance at the 5% level. The Insight scale, however, produced a slightly stronger result (r=.105, p<.05), albeit with doubtful practical significance. Such information may provide indications as to the nature of informative predictors in National Diploma study.

In the 2011 intake, considerably more significant results (p<.05) were achieved than in the 2010 intake. APS produced a correlation of r=.194 (p<.01) with the PIBSpEEx Total scale, translating to an explanation of approximately 4% of variance. A similar correlation was seen with average marks (r=.193, p<.01). In this year of intake, the PIBSpEEx Total score produced a significant correlation with average of all marks (r=.126, p<.01), explaining approximately 1.6% of variance, a similar result to that seen in 2010. This provides some indication of the stability of the instrument over the years. The same applies to the relationship between APS score and average marks.

In the 2011 intake (unlike for 2010), APS score correlated significantly (p<.01) with all seven PIBSpEEx scales. The correlations between the PIBSpEEx scales and the Total scale were similar to those seen in 2010. However, in this year, the strength of relationship between the Observance scale and average mark increased. For the other six scales, similar relationships were produced, although significance levels varied in comparison to the 2010 intake. In order to further investigate these relationships and the potential individual and combined predictive power of APS and the PIBSpEEx scales, linear and multiple regressions were conducted utilising average marks as the dependent variable.

Prediction of Average Mark: Linear, Multiple, Stepwise and Logistic Regressions

Multiple And Stepwise Regression: APS And PIBSpEEx Total Scale To Predict Average Marks

Previous analyses demonstrated the data were sufficiently normally distributed to meet the assumption of normality (note the transformation of the APS variable). Examination of scatter plots provided an indication of the homoscedasticity (the variance in the dependent

variable being constant across all values of the independent variable) and linearity were sufficient for utilisation of linear regression (Tabachnick & Fidell, 1989). It was found that the data met other assumptions required for the use of linear regression including: Related pairs of scores; at least an ordinal level of measurement; homoscedasticity of the dependent variable and; linearity of relationship (Tabachnick & Fidell, 1989; Ho, 2006).

Multiple and stepwise regression: Individual PIBSpEEx scales as predictors of average marks.

Multiple regression.

An examination of a multiple regression model consisting of the seven PIBSpEEx scales in combination as predictors produced the following results for the 2010 and 2011 intakes:

Table 13:
Multiple regression model summary: PIBSpEEx scales to predict average of all marks

Year of Intake	*Scale*	*r*	R^2	*% Variance Explained*	*β*	*t*	*p*
2010 Intake	Conceptualisation	.084**	.007	0.71	0.032	1.355	.185
	Mental Alertness	.065*	.004	0.42	0.006	.168	.872
	Observance	.090**	.008	0.82	0.057	1.712	.129
	Insight	.105*	.011	1.11	0.075	1.405	.219
	Calculations	.042	.002	0.18	-0.013	-.267	.800
	Object Assembly	.061	.004	0.37	0.015	.331	.753
	Reading Comprehension	.013*	.005	0.55	0.034	1.082	.310
2011 Intake	Conceptualisation	.081*	.007	0.66	0.020	.600	.564
	Mental Alertness	.075*	.006	0.56	0.013	.498	.627
	Observance	.109**	.012	1.18	0.077	3.409	.004
	Insight	.105*	.011	1.09	0.066	1.343	.236
	Calculations	.044*	.002	0.19	-0.017	-.435	.679
	Object Assembly	.059*	.003	0.35	0.008	.293	.775
	Reading Comprehension	.087*	.008	0.75	0.044	1.329	.226

*Note: *β indicates the standardised coefficient*

The above multiple regression model produced the following model summary statistics:

Table 14:
Multiple regression on average of all marks utilising the PIBSpEEx subscales

	R	R^2	*F*	*Sig*
2010	.153	.022	13.692	.000
2011	.155	.023	16.217	.000

In 2010, the multiple regression model achieved a significant fit (F=13.692, p=.000) indicating that some form of linear relationship exists between the independent predictors and the dependent variable. An examination of standardised regression coefficients (β) provided

an indication of the relative strength of relationship between each predictor and the dependent variable (average mark) in this model. As can be seen in Table 14, the strongest predictors for the 2010 intake were Insight, Observance and Reading Comprehension (this was confirmed by examination of the correlations table). Conceptualisation also made a positive contribution to the model but to a lesser extent. Mental Alertness, Calculations and Object Assembly evidenced contributions very close to zero and negative in the case of Calculations. Therefore, it appears that in this year of intake, the primary contribution to the relationship was a result of the Insight, Observance, Conceptualisation and Reading Comprehension scales. However, none of the individual predictors achieved statistical significance.

In 2011, similar standardised regression coefficients were produced although the model did achieve a significant fit (F=16.217, p=.000). For this year of intake, the Observance and Insight scales produced the highest standardised regression coefficients followed by the Reading Comprehension scale. However, only the Observance scale achieved statistical significance (t=3.409, p=.004).

Despite the lack of significant individual predictors and low coefficients of determination, the model did achieve statistical significance. It was of interest to understand the relative importance of each predictor and increases in the predictive model, In order to achieve this, several regression models were created. Each model began with the entry of the strongest correlating PIBSpEEx scale with average mark (Insight in 2010 and Observance in 2011). Several two variable multiple regression models were then created in order to identify which other PIBSpEEx scales contributed the most in terms of additional variance explained (the aforementioned scales remained in each model with each of the other scales being examined in turn). Once the scales explaining the most additional variance were identified, they were utilised in stepwise regression models.

Stepwise regression: 2010 intake.

The full model inclusive of the three predictors achieved a significant fit (F=26.436, p=.000) with the data. The following table summarises the results of the stepwise regression utilising the three best predicting PIBSpEEx scales for the 2010 intake in terms of the pooled result:

Table 15:
Stepwise regression 2010 intake: Three PIBSpEEx scales

Model	R^2	R^2 *Change*	*F Change*	*p*
1	.012	.012	48.093	.000
2	.018	.006	22.521	.005
3	.019	.002	6.538	.041

1. *Insight*
2. *Insight + Observance*
3. *Insight + Observance + Conceptualisation*

The following standardised regression β values and their relative significance in the predictive model were produced (Table 16):

Table 16:
Stepwise regression: Three PIBSpEEx scales: Standardised β values and significance

	β	*t*	*p*
Insight	0.081	1.711	.146
Observance	0.061	1.738	.127
Conceptualisation	0.042	1.755	.097

*Note: *β indicates the standardised coefficient*

The results indicate that Insight variable alone explained approximately 1.2% of variance. Further addition of the Observance scale achieved a significant (p<.01) increase in the amount of variance explained, accounting for a further approximate 0.6% of variance and increasing the total variance explained to approximately 1.7%. Addition of the Conceptualisation scale was significant (p=.041) and explained a further 0.2% of variance creating a total explanation of 1.9% of variance by the model (please note the potential for rounding error, values are reported to three decimal places only). If we compare this to the full multiple regression model (all PIBSpEEx scales), we find that the full model explained a total of 2.2% of variance meaning only approximately 0.3% of variance (in addition to the 1.9% explained by the three scale model) was further explained by the addition of the other four PIBSpEEx scales.

Despite producing significant changes in the percentage of variance explained, none of the individual standardised coefficients achieved statistical significance. Therefore, as for the previous model utilising all seven scales, although the model did achieve significance and a significance change in R^2 was produced, none of the individual predictor variables were significant.

Stepwise regression: 2011 intake.

The 2011 intake model achieved significant fit (F=34.729, p=.000). The following table summarises the results of the stepwise regression for the 2011 intake utilising the three best predictor scales as determined by the multiple regression model:

Table 17:
Stepwise regression 2011 intake: Three PIBSpEEx scales

Model	R^2	R^2 *Change*	*F Change*	*P*
1	.012	.012	55.163	.000
2	.020	.008	35.908	.006
3	.022	.003	12.468	.077

1. *Observance*
2. *Observance + Insight*
3. *Observance + Insight + Reading Comprehension*

The following standardised β weights and their associated significance were produced for this stepwise model (Table 18):

Table 18:
Stepwise regression: Three PIBSpEEx scales: Standardised β values and significance

	β	*t*	*p*
Observance	0.082	3.645	.003
Insight	0.071	1.493	.196
Reading Comprehension	0.049	1.438	.197

*Note: *β indicates the standardised coefficient*

For the 2011 intake, an initial 1.2% of variance was explained in a significant model utilising the Observance scale (F=55.163, p=.000). Introduction of the Insight scale explained a further 0.8% of variance in a significant contribution. Further introduction of the Reading Comprehension scale did not produce a significant increase in variance explained, accounting for a further 0.3% of variance in the model as a whole. A total of 2.2% of variance was explained by the three scale model, leaving only 0.2% to be further accounted for by the remaining four scales (as per the previous seven scale model).

The standardised regression coefficients produced demonstrated that only the Observance scale was a significant predictor of average mark within this model, despite significance increases in variance explained by the addition of the Insight scale (see Table 17).

In conclusion, it appears that the Observance and Insight scales in combination, are the two major factors in the predictive power of the PIBSpEEx instrument for this data. Although statistical significance was not always achieved, they do appear to contribute somewhat to the predictive power of a statistically significant model. In order to assess what

these specific scales, and the PIBSpEEx scale as a whole, may add to the base predictor of APS score, further multiple and stepwise regressions were conducted.

Multiple regression: APS and PIBSpEEx in combination as predictors of average marks.

The following pooled results were obtained for the multiple regression model. This model utilised the two predictors of the Log10 transformed APS variable and the PIBSpEEx Total score combined in a single multiple regression model:

Table 19:
Model statistics: Multiple regression model consisting of APS (Log10 Transformed) and PIBSpEEx Total combined

	R	R^2	*F*	*Sig*
2010	.209	.044	84.657	.000
2011	.213	.045	103.782	.000

For the 2010 intake, this model achieved a significant fit (F=84.657, p=.000). An approximate 4.3% of variance in the dependent variable (average mark) was explained by the model. In 2011, the model also achieved a significant fit (F=103.782, p=.000). For this year of intake an approximate 4.5% of variance was explained by the model. An examination of Pearson's r indicated than in 2010, a correlation coefficient of r=.209 was achieved and in 2011 this increased to r=.213. These coefficients are somewhat higher than those evidenced by the individual predictors (see earlier in the text).

Table 20:
Model statistics: Multiple regression: APS and PIBSpEEx Total combined

Year of Intake	*Scale*	*r*	R^2	*% Variance Explained*	*β*	*t*	*p*
2010 Intake	APS	.172**	.030	3.00	0.170	10.534	.000
	PIBSpEEx Total	.122**	.015	1.50	0.117	4.337	.002
2011 Intake	APS	.193**	.037	3.70	0.175	11.120	.000
	PIBSpEEx Total	.126**	.016	1.60	0.089	2.718	.032

Note: *β indicates the standardised coefficient*
**Significant at the .05 level*
***Significant at the .01 level*

For the 2010 intake, the multiple regression model APS proved to be the stronger predictor (β=0.170, t=10.534, p=.000). The PIBSpEEx Total score demonstrated slightly less prominence but also proved significant (β=0.117, t=4.337, p=.002). In the 2011 intake, a similar result was achieved for APS (β=0.175, t=11.120, p=.000). The relative predictive power of the PIBSpEEx total on the other hand diminished somewhat but did retain significance at the 5% level (β=0.089, t=2.718, p=.032).

As can be seen by the results, for both years of intake and both variables, the coefficients were positive. Therefore, higher scores on the predictor variables were associated with higher scores in the dependent variable. In the 2010 intake, of the 4.3% of variance explained by the full model, 3.0% was accounted for by APS (bear in mind the adjusted coefficients of determination in the full model will cause some discrepancy in total variance explained when compared to unadjusted coefficients. In the 2011 intake, 3.7% of 4.5% variance (note caveat on adjustment in the full model) was explained by APS score. These results clearly indicate that the full model does explain some variance, primarily accounted for by APS score with contribution from the PIBSpEEx Total score. In order to further explore these relationships stepwise regression models were created to explore real changes in percentage of variance explained by each predictor throughout the model. The initial model utilised the previously identified PIBSpEEx scales along with APS, entered in order of priority of variance explained with consideration to primacy in utilisation during selection processes. Therefore, for the first model, APS was entered first followed by the PIBSpEEx scales in the order of priority determined previously.

Stepwise regression: Best predictors of average marks.

Individual PIBSpEEx scale predictors and APS.

Although the APS Total score provided somewhat better prediction capacity than any individual scale, it was of interest to consider the previously mentioned three best predictive PIBSpEEx scales in conjunction with APS scores for the purposes of comparison to the model utilising the Total scale and APS scores. Therefore stepwise regression models were created utilising the four variables. APS was entered first into the model. The remaining three variables were selected by examination of a series of multiple (two predictor) regression models, each adding one PIBSpEEx scale individually (i.e. a series of two variable regression models). The scales explaining the most additional variance in combination with APS were utilised in order of amount of variance explained. For the 2010 intake the following scales were utilised, in order of entry: APS score, Insight scale, Observance scale and Conceptualisation scale. For the 2010 intake, the full model achieved significant fit (F=46.008, p=.000). The following changes in variance were observed (Table 21):

Table 21:
Stepwise regression 2010 intake: APS and 3 PIBSpEEx scale model

Model	R^2	R^2 Change	F Change	*p*
1	.030	.030	113.138	.000
2	.041	.011	43.862	.000
3	.046	.005	18.746	.023
4	.047	.002	6.364	.048

1. *APS*
2. *APS + Insight*
3. *APS + Insight + Observance*
4. *APS + Insight + Observance + Conceptualisation*

The individual predictors produced the following standardised regression coefficients and associated levels of significance:

Table 22:
Stepwise regression 2010 intake: APS Log10 and three PIBSpEEx scales: Standardised β values and significance

	β	*t*	*p*
APS	0.170	10.484	.000
Observance	0.079	1.722	.142
Insight	0.055	1.549	.167
Conceptualisation	0.042	1.698	.109

*Note: *β indicates the standardised coefficient*

As can be seen in Table 21, the full model explained a total of 4.7% of variance in average mark. APS alone explained 3.0% of the total variance. The introduction of the Insight scale was significant (F=43.862, p=.000), explaining a further 1.1% of variance. Introduction of the Observance scale to the model was also significant (F=18.746, p=.023), albeit at the 5% rather than 1% level. However, the introduction of this predictor only explained a further 0.5% of variance. Introduction of the Conceptualisation scale did produce significant change (F=6.364, p=.048), explaining only a further 0.2% of variance. It appears, in the case of this model, that the introduction of the Insight scale alongside APS was fairly useful; however, introduction of the Observance and Conceptualisation scales did not produce particularly impressive results in terms of percentage of variance explained. Interestingly, the model as a whole was as strong as the previous regression analysis model utilising APS and the Total PIBSpEEx scale. Despite the significance of the model and changes in variance explained, only the APS predictor proved significant. As for the previous models, none of the PIBSpEEx predictors achieved statistical significance in terms of standardised coefficients.

In the 2011 year of entry, the full model utilised APS score, Observance, Insight and Reading Comprehension in that order of priority. The model achieved a significant fit

(*F*=58.461, *p*=.000). The following coefficients of determination and changes in variance explained with the introduction of additional predictors were found (Table 23):

Table 23:
Stepwise regression 2011 intake: APS and 3 PIBSpEEx scale model

Model	R^2	R^2 *Change*	*F Change*	*p*
1	.030	.030	113.138	.000
2	.037	.007	28.706	.000
3	.046	.009	33.861	.005
4	.048	.002	7.663	.157

1. *APS*
2. *APS + Observance*
3. *APS + Observance + Insight*
4. *APS + Observance + Insight + Reading Comprehension*

The model initially described approximately 3.0% of a total of 4.8% of variance through use of the APS variable. Further introduction of the Observance variable was significant (*F*=28.706, *p*=.000), producing an explanation of a further 0.7% of variance. Introduction of the Insight scale explained an additional 0.9% of variance and was significant (*F*=33.861, *p*=.005). However, introducing the Reading Comprehension scale did not produce significant change (*F*=7.663, *p*=.157), explaining only a further 0.2% of variance. The individual predictors produced the following standardised regression coefficients and associated significance levels:

Table 24:
Stepwise regression 2011 intake: APS Log10 and three PIBSpEEx scales: Standardised β values and significance

	β	*t*	*p*
APS	0.174	11.040	.000
Observance	0.068	3.195	.005
Insight	0.052	1.065	.336
Reading Comprehension	0.037	1.122	.300

*Note: *β indicates the standardised coefficient*

Similarly to the 2010 intake, the APS variable proved significant. In this year of entry, the Observance scale also proved significant at the 1% level. Based on this information, it appears that variance in average mark is attributable primarily to APS and the Observance scale. This is of interest in comparison to the 2010 intake model, in which introduction of first Insight and then Observance scales were both significant. However, the 2011 intake model explained 5% of variance as opposed to the 4.7% of variance explained by the 2010 model. Both models explained more variance than the model incorporating APS score and PIBSpEEx Total score.

In order to understand such complex relationships in a more practical fashion, logistic regression was conducted to better understand increased likelihoods of simple pass versus fail outcomes. A variety of predictors were considered in relation to pass versus fail including demographics, APS, the PIBSpEEx Total score and the aforementioned PIBSpEEx scales which appeared to contribute largely to the explained variance in average mark (Observance and Insight).

Logistic Regression To Predict Pass/Fail

Demographics and pass/fail.

Logistic regression was utilised to examine the likelihood of demographic group membership being linked to passing or failing. For the 2010 data, a significant model was produced. It was found that females were 1.223 times more likely to pass (over 50% average) than males (W=8.815, p=.003). In the 2011 intake, this figure was slightly lower, with females being 1.091 times more likely to pass than males, a non-significant result (W=1.804, p=.183).

Significant results (p<.05) were obtained when considering Residency and Bursary status in terms of passing vs. failing. Students from the 2010 intake who were residing in residency were 2.537 times more likely to fall into the pass group (W=136.853, p=.000). For the 2011 intake this figure was 2.906 (W=188.939, p=.000). Students holding bursaries were 2.362 times more likely to be in the pass group (W=154.358, p=.000) for the 2010 intake and 2.035 times more likely (W=113.775, p=.000) to be in the pass group for the 2011 intake. These results seem to indicate that although only small differences were found between the groups, certain group memberships do appear to have an impact on passing or failing according to average marks.

APS as a predictor of likelihood pass/fail.

Since logistic regression does not assume normal distribution in continuous predictor variables (Burns & Burns, 2009), the non-transformed APS variable was utilised for an accurate result in terms of specific increases in units. The results of the analysis for the 2010 intake were produced a significant model (χ^2=115.509, p=.000) indicating a significant difference after the introduction of the predictor variable. Each unit increase in APS (i.e. each point of score) was associated with an increase of 1.081 (8.1%) in likelihood of passing or failing which, despite being statistically significant (W=108.633, p=.000) is not particularly impressive on a practical level. In the 2011 intake, a similarly significant model was

produced (χ^2=87.216, *p*=.000). The result observed was a likely increase of 1.063 (6.3%) (*W*=79.292, *p*=.000) being associated with every one point increase in APS.

PIBSpEEx Total scale as predictor of likelihood of pass/fail.

For the 2010 intake, utilising the PIBSpEEx Total score as the predictor variable, for every one unit increase in the PIBSpEEx total, students were 1.032 (3.2%) (*W*=29.752, *p*=.000) more likely to pass. This model achieved a significant goodness-of-fit (χ^2=30.213, *p*=.000) indicating a significant difference between the model with no predictors and the model including the PIBSpEEx Total score as a predictor. For the 2011 intake, unit increases in the PIBSpEEx Total resulted in a significant model (χ^2=42.603, *p*=.000) where each increase was associated with a significant (*W*=41.581, *p*=.009) 3.5% increase in likelihood to pass (i.e. students were 1.035 times more likely to pass).

Specific PIBSpEEx scales as predictors of likelihood of pass/fail.

The results of the logistic regression models as per PIBSpEEx scale are presented in Table 21. These results may be somewhat more practically relevant than those produced by the Total scale alone.

Table 25:
Logistic regression analysis utilising the three strongest PIBSpEEx scales in separate models

Year of Intake	*Scale*	χ^2	*P*	*Wald*	*P*	*Exp(B)*	*% increased likelihood to pass*
2010	Observance	17.958	.000	17.815	.013	1.155	15.0
	Insight	23.488	.012	23.149	.064	1.112	11.2
2011	Observance	38.528	.000	38.033	.000	1.225	22.5
	Insight	25.599	.022	24.098	.138	1.103	10.3

The results clearly indicate that increases in the Observance scale produce a higher likelihood of passing than increases in the Insight scale. While the PIBSpEEx Total scale provided only a 3.2% (2010) and 3.5% (2011) increase in likelihood to pass with each unit increase, the individual scales Observance and Insight seem to function somewhat better, Observance being more impressive. However, in neither intake did the Insight scale did achieve statistical significance (*p*>.05) as a predictor. At face value and, potentially for practical purposes, the PIBSpEEx scale Observance may be more impressive than either APS or the PIBSpEEx total scale. It is possible that the simplification of the average mark variable into a binary variable reduced the effects of outliers, altering the predictive power of the PIBSpEEx scales.

Chapter 5: Discussion

Notes Regarding APS and the PIBSpEEx

Implications Of APS Distribution

Prior to commencing the discussion, it is important to understand two findings concerning the data. A preliminary analysis of the instruments revealed statistics of skewness and kurtosis which were within normal bounds. The important exception to this rule was APS score, which produced a positively skewed distribution. Although this was dealt with statistically for the purposes of inferential analysis, it is important to understand in terms of the data provided. Positively skewed distributions create a 'bulge' on the left hand side (in this case, lower APS value) of the distribution. Therefore, it appears that the majority of students, by virtue of selection criteria or similar, obtained fairly low APS scores (in comparison to the potentially normal distribution). Although issues of range restriction will be explored further in the 'Limitations' chapter, it is important at this juncture to understand the theoretical impact of lower APS scores on the dependent and other predictor variables.

If we were to construct a hypothetical relationship between general academic achievement (secondary and tertiary) and cognitive function, we would expect students with higher cognitive function to perform better academically (bearing in mind the caveats and complexities laid down in the literature as previously discussed). In addition, the institution at which this study was conducted demonstrated somewhat lower entry requirements than many of the academic Universities. Therefore, what may be found is an influx of students, with lower APS, to these specific types of institution by virtue of restricted choice. Obviously, such information should be understood in the context of poorly functioning secondary schooling, with poor academic achievement and high drop-out, whereby only around 5% obtaining Senior Certificate endorsement for tertiary study with the majority of those being White (Fisher & Scott, 2011). In the context of promotion of mass participation and redress of racial inequalities in the Higher Education system (Wangenge-Ouma & Cloete, 2008), with growth of African enrolments increasing by around 80% between 1993 and 1999 (post-apartheid) (Fisher & Scott, 2011), a disproportionate number of African students are enrolled for University of Technology rather than Academic University studies, potentially a reflection of secondary schooling performance. Logically, such achievement issues may then be reflected in likelihood to pass or fail since students may be entering such institutions through ability to meet entry requirements rather than preference of programme, both of which are significant factors in choice of institution (Jordaan & Wiese, 2010).

Further discussion will be centered around the relative demographic differences in the various predictor and dependent scales, as well as relationships between the scales and predictive value of various scales. Hopefully, this will result in a better understanding of demographic differences in success and how the current selection instruments operate (effectively or ineffectively) where the sole purpose is predicting success in National Diploma courses.

Structure Of The PIBSpEEx

Prior to understanding the relationships between the three continuous variables, a note on the structure of the PIBSpEEx is required. It was initially postulated that the seven PIBSpEEx scales could be further differentiated into a 'Verbal', 'Non-verbal' and 'Language' category (please see the 'Methods' section for further explanation. However, factor analytic procedures failed to confirm this categorisation. Indeed, the analyses produced a fairly weak structure (which may have been strengthened if more items had been present), tentatively indicating that Mental Alertness, Insight, Calculations and Reading Comprehension created one factor with Conceptualisation and Object Assembly as a second factor and Observance, alone, as a third factor. Factor analyses are less stable with fewer variables per factor and, therefore, less reliable (Howitt & Cramer, 2011). In any factor analysis it is important to realise that plausibility (through confirmation of theory or exploratory) is not guaranteed, despite superficial appearance as such (Hair, Anderson, & Tatham, 1987). However, it is important to understand the structure and make up of this instrument for the purposes of this study, even if only in a tentative manner and subject to interpretive limitations.

As a tentative interpretation of the results, it appears that the first factor included scales heavily loaded in English. All four scales, at least in part, tested understanding and reasoning within the English language including memorisation (Reading Comprehension). The Calculations scale is included in this group, bearing in mind many of the items consist of word/numerical problems. Conceptualisation and Object Assembly both involve 'building' non-verbal items: Conceptualisation through merging of two pictures and Object Assembly through mental spatial manipulation. It appears that this may be the reason they loaded on a single factor. Observance, which involves identifying the odd picture out, both in terms of concrete, everyday objects and abstract pictures, appears to measure a different aspect of cognition to the other six scales. Needless to say, based on the results, these conclusions are tentative at best. However, a full understanding of the way the scales operate and potential groupings of scales will be important for interpretation of later analyses.

Demographic Differences

Summary Of Results

Independent samples T-Tests conducted on Gender, Residence and Bursary variables produced some interesting findings. In the 2010 intake no significant differences were found between the two genders in terms of APS score. However, a significant difference was found in the 2011 intake. Significant differences were found for both intakes for Bursary status and there was a significant difference between Residency statuses in the 2010 intake although for 2011 the value did approach significance. For Bursary and Residency, in both years of intake, students holding a bursary or funding had higher APS scores, in 2011 Females had significantly higher APS scores but in 2010 Males had higher scores (*n.s.*). The general theme noted in these results centres around Bursary status and Residency status. Importantly, these significant results were replicated for average mark obtained (with the exception that Females obtained significantly higher marks in both years of intake). However, the results were not replicated for scores on the PIBSpEEx instruments, lending some support to Erasmus' (2004) claim of a gender, culture and socio-economic status neutral assessment.

Further analyses utilising logistic regression attempted to understand these results better. Females in the 2010 intake were 1.223 (22.3%) more likely to pass, a figure which dropped slightly for the 2011 year of entry to 1.091. Students in residency were 2.537 (153.7%) times more likely to pass, a figure which increased to 2.906 (190.6%) in 2011. Similar results were observed for bursaries with those obtaining bursaries or funding being significantly more likely to fall into the pass group for both years of intake. It appears that by simplifying the dependent variable to binary coding, although finer differences in terms of variance explained may be missed, a simpler model is produced making the differences between these groups clearer.

Gender

Females appear to be performing slightly better in tertiary education in this sample (in terms of pass/fail and percentage of variance explained). However, the reasons behind this are unclear. An examination of effect size does indicate that the gender differences in performance are fairly small, despite achieving statistical significance (see the 'Limitations' chapter regarding effect size, sample size and statistical significance). International studies have shown that females are more likely to enrol in tertiary education, particularly

proportionately from lower income groupings (Jacob, 2002). This trend is reflected in current higher education in South Africa (Fisher & Scott, 2011).

The gender gap in attainment in South Africa appears to be linked to racial grouping. Across all groups, the National average is slightly in favour of men obtaining post-secondary education (12.6% to 12.3%) with more females having little or no schooling. However, for African persons specifically, this ratio is reversed with 8.9% of females to 8.3% of males obtaining tertiary qualifications although females were still more likely to obtain no schooling or less than Grade 12 than males (Statistics South Africa, 2011). A study in Australia (Collins, Kenway, & McLeod, 2000) provided some interesting insights into the value and purpose of education between males and females which may be somewhat applicable to the South African context, despite socio-economic and developmental differences. Increased training opportunities are available (e.g. trades) following secondary school for boys. Girls tended to value education in terms of potential future attainment, while boys tended to value tertiary schooling in terms only of economic advancement, thereby reducing motivation when careers did not specifically require educational attainment for entry.

Limited options available to girls following secondary schooling (without further attainment) were also noted by Jacob (2002) in an American study and seem to be a world-wide trend. This may significantly impact motivation of girls to succeed in tertiary schooling. Jacob (2002) also found less negative and 'dislike' perceptions of girls as opposed to boys with regards to schooling, perhaps fuelling enjoyment of studying and motivation to succeed. Little research in the South African context is available regarding specific factors in increased success amongst African females as opposed to males, although the phenomenon is certainly well studied statistically.

Bursaries Or Funding

It does appear that students with bursaries or funding perform better in general. This was confirmed by medium effect sizes for these group differences. For APS scores, this difference may be related to selection requirements. Unfortunately, in this study, bursaries and NSFAS funding were not separated in the data obtained from the institution, so it is difficult to determine if one of these categories skewed the distribution (for example, higher APS scores leading to higher likelihood of obtaining a bursary) which would also, by logical extension, lead to higher likelihood of passing. However, a study in Sri Lanka, where tertiary

education is free for all citizens and offers a number of incentives such as free books and meals, demonstrated that children from affluent or middle class backgrounds were still more likely to succeed in tertiary education (Ranasinghe & Hartog, 2002), regardless of freedom from what have been previously thought of as concerns likely to inhibit success. These findings are in keeping with long-known findings of socio-economic status impacting success rates negatively (Sewell, 1971), although they may be related to findings, as replicated in this study, that lower socio-economic status' impact on success may be mediated by factors such as language ability, maternal education, access to resources and living conditions (Jednoro, *et al.*, 2012; Ranasinghe & Hartog, 2002). Although we find in this study that funded students tended to perform better, in general the cohort of students utilised for the study as a whole and, indeed, likely to enrol at a University of Technology, is likely to come from a similar lower socio-economic status background. Therefore, the most likely explanation is not only financial, but at least partially due to the lack of differentiation between NSFAS funding students and those who obtained merit bursaries.

Residency

Better performance of students in residence during tertiary education may be related to a number of factors, including decreased travel requirements, increased study time, motivation not to lose places in the residencies after first year and presence of motivating peers. However, these explanations are not pertinent as to why such students also had higher APS values. It has been found, in international studies, that living in student housing (or residence) has a positive effect on retention, adjustment and performance (Pascarella & Terenzini, 2005), although this is not necessarily generalisable to other contexts. Some factors cited for this improvement in results include participation in on-campus activities, additional interaction with peers and faculty, positivity towards, and satisfaction with, living environments and better psychosocial adjustment to University life (Department: Higher Educaton and Trianing, 2011). However, the same report noted a number of international studies, which have produced conflicting findings, pointing to potential additional socio-economic privilege of students housed in residency, which may impact this relationship and is also likely to have bearing on the finding that students in residency had obtained higher APS values (also linked to success in tertiary study).

In general, it does appear that being housed in residences and obtaining a bursary or NSFAS support may have an impact on likelihood to pass and average mark obtained in tertiary education. However, small effect sizes alongside high statistical significance do not

clearly indicate how strong an effect these group memberships are likely to have. There are several intuitively logical explanations for such relationships, including selection procedures, early applications, increased commitment, decreased travel time, decreased financial stress, increased finances available for purchase of books and materials, lack of familial distractions and so on.

Ethnicity And Home Language

Ethnicity and Home Language were also explored. ANOVA results (Brown-Forsythe *F* where variance was not equal) indicated that significant differences existed in APS scores between the different ethnicities and home languages. This is most probably reflected in the National finding that African students have long been over-represented in Universities of Technology with lower entry requirements and under-represented in Academic Universities (Fisher & Scott, 2011). Further scrutinization of Tukey's HSD revealed these differences to lie primarily between the White group and other groupings as well as between the Afrikaans group and other groupings (for both the 2010 and 2011 intake), again reflecting the recent make up of tertiary institution type ethnic profiles (Fisher & Scott, 2011).

Similar results were found for the PIBSpEEx performance with Afrikaans and Afrikaans/English and White students performing better on the instrument. Ethnic differences were limited to significance in the 2011 intake only. For the PIBSpEEx, further examination of the effect size (partial η^2) indicated that only around 1.7% of variance was explained by these differences. Similar results were also found for average mark obtained, with significant differences according to Ethnicity and Home Language lying with Whites and Afrikaans groups performing better. Somewhat larger effect sizes were reported in this case with 3.8% and 2.0% of variance being explained by Ethnicity differences in 2010 and 2011. Figures of 3.5% and 1.4% were found for Home Language.

Upon initial noting of results, immediate consideration would have been given to the possibility of the PIBSpEEx operating differently for White and/or Afrikaans students. Initial norming and research into the assessment purported culture fairness (Erasmus, 2004) and, despite the apparent differences found here, it appears this is the case. The White group and Afrikaans group performed better across all the variables considered (APS, PIBSpEEx, average mark). Such discrepancies have been well noted in recent research, pertaining to both participation and success rates in South Africa (Statistics South Africa, 2011). However, less conclusive information is available as to why this could be the case. In addition, a lack of

conclusive research exists on precisely which factors are responsible for this inconsistency, although socio-economic status has been implicated in a number of local and international studies despite a lack of clarity on the precise mechanisms of causality (Fisher & Scott, 2011; Jordaan & Wiese, 2010; Ranasinghe & Hartog, 2002).

What is important to note from these findings, aside from confirmation of previously observed statistical studies regarding participation and success, is the potential confirmation of Erasmus' (2004) claim of the culture-fair operation of the PIBSpEEx instrument. Although the instrument did demonstrate statistically significant differences, these were in line with those observed in both APS and average marks, potentially indicating an underlying explanatory factor creating improved performance in all three variables but being unlikely to indicate cultural bias in the instrument itself. However, this conclusion is open to interpretation.

Relationships between APS, PIBSpEEx and Average Mark

An exploration of the relationships between APS, PIBSpEEx and average marks was necessary to understand potential associations between these variables. Review of the correlation coefficients indicated a number of significant correlations. Most importantly, in the 2010 year of intake, significant correlations were found between APS and the PIBSpEEx Total score and average marks. In addition, the Conceptualisation, Mental Alertness, Observance, Insight and Reading Comprehension scales produced significant correlations while the Calculations and Object assembly scales did not. Similar results were observed for the 2011 year of intake with similar coefficients. However, in this year of intake the Calculations scale also achieved statistical significance. When considering later findings (see later in this discussion), it is important to understand the possibility of poorly correlated PIBSpEEx scales. From the analyses, it appears that the Calculations and Object Assembly scales are not well correlated with average marks (although, in general, none of the variables achieved correlations exceeding r=.200). None of the PIBSpEEx scales correlated significantly with APS score in the 2010 intake, but this changed in the 2011 intake which saw a number of highly significant correlations. This is most probably a by-product of standard error within the multiple imputation process since the data for the 2011 year of entry was initially more complete.

These relationships seem to indicate a number of important points for correct understanding of later analyses. Initially, we may note that the Calculations and Object Assembly scales may, in fact, be detrimental to the predictive power of the instrument as a whole. Of more concern, stronger correlations were expected between APS and average mark. APS is a limiting factor for entry into tertiary education systems, with Universities, Comprehensives and Universities of Technology instituting limitations, minimum requirements and various preferences under the assumption that secondary schooling will best predict tertiary success. However, the relationship in this study does not point to a particularly strong association between secondary and tertiary schooling results. Another point to note is, when considering only the 2011 year of entry (intake) the correlations between the PIBSpEEx scales and APS score were considerably stronger than those between the PIBSpEEx scales and average mark although weaker than the relationship between APS and average mark. Putting aside the reasoning behind the discrepancy between the 2010 and 2011 intake data, this may point to an important association between current schooling and the PIBSpEEx scales. The exception to this point is the Observance scale, which achieved similar correlations with APS and with average marks. As observed in the results, this scale achieved the strongest predictive power in the model. In general, scales producing greater predictive power, correlated at similar strengths with APS and average mark. Scales producing less predictive power, tended to correlate more strongly with APS than with average mark.

Individual Predictors: APS and PIBSpEEx Scales

Initially, models were produced utilising APS and the PIBSpEEx Total and individual scales as separate, individual predictors of average mark. To begin with three models were created: Linear regression utilising the PIBSpEEx Total score, multiple linear regression utilising the seven PIBSpEEx scales and linear regression utilising APS scores. The initial models were utilised for the purposes of understanding the relative importance and predictive capacity of the variables. Later in the discussion the combined predictive power and relative importance of predictors is considered. Logistic regression models added to this understanding utilising a simpler outcome variable.

PIBSpEEx

The first model created utilised the PIBSpEEx instrument as individual scales in a multiple regression model. A logistic regression model was produced utilising the Total score only

(and then further refined through the aforementioned analysis). The logistic regression revealed that for every unit increase in the PIBSpEEx Total in the 2010 year of entry, a concomitant increase of 3.2% in likelihood to pass was evidenced. For the 2011 year of entry a similar figure was produced where chances of passing increased by 3.5% for every point increase in the PIBSpEEx scale. As will be discussed later, these figures were somewhat lower than those produced by APS as a predictive variable. Following the tentative factor analysis results and correlation matrices we could consider the relative prominence of each PIBSpEEx scale and examination of productivity in terms of predictive power. Suffice to note that increases in the PIBSpEEx scale were associated with increases in likelihood to pass.

The individual scales of the PIBSpEEx instrument were examined in an attempt to further understand the significant correlation obtained with average mark. Initially, a multiple regression model was produced, entering all seven PIBSpEEx scales. The model was examined for the relative importance of predictors, significance and percentage of variance explained. Although a number of significant results were obtained, the full model did not explain more than 2.2% of variance in average mark for the 2010 intake and 2.3% of variance in the 2011 intake (note: the model fit was significant) well below the recommended rate of 20% or 30% for selection instruments (Anastasi & Urbina, 1997). These results were not dissimilar to those obtained for APS (see below). It was already known that R^2 values were low (based on the correlation matrix). Therefore, the point of interest in this analysis was identification of stronger and weaker scales within the instrument as a whole. An examination of the β values provided this information. For the 2010 intake, Insight, Observance and Conceptualisation were identified as the three strongest contributors to the model (in that order). For the 2011 intake, this changed slightly with Observance being the strongest contributor followed by Insight and Reading Comprehension. Further examination revealed that the majority of variance in average mark explained by the model as a whole was accounted for by the Observance and Insight scales.

These results are somewhat contradictory to prior studies (reported by Kriel and Dockrat) of the PIBSpEEx for validation purposes at this same institution (Potential Assessment: A Historical Overview, n.d.). In previous studies between 60% and 90% of variance was explained by the instrument. However, these studies were conducted on specific courses, first year marks in one subject specifically and utilising pre-accepted, higher APS students. Therefore, such studies were limited in sample size and generality when compared

to the conditions utilised in the present study. Therefore they were subject to a variety of sources of bias, potentially providing a partial explanation of contradictory results. It is also possible that educational objectives, entry requirements, standards of secondary education and other factors may have changed in the 10 or so years following the initial research, particularly with the introduction of the new curriculum and secondary education objectives in the late 2000's.

Since three particular scales were identified as being strongest contributors to the regression model, their order of priority was retained as per year of intake and the three alone were used in combination in a stepwise regression model with average mark as the outcome variable. It was hoped that relative increases in variance explained could be better examined in this way. For both the 2010 and 2011 intakes, the Observance and Insight scales accounted for the majority of variance. In 2010 this amounted to 1.8% of a total 1.9% in the three scale model. In 2011, this figure was approximately 2.0% of a total of 2.2% in the three scale model. Further logistic regression analyses of these three scales individually provided further insight into predictive capabilities. The values produced were considerably higher than those evidenced by APS or the PIBSpEEx Total score (see below regarding APS values). In the 2010 intake, increases in the Observance scale were associated with a 15.5% increase in likelihood to pass. Similar values were evidenced for the Insight scale (11.2%). In the 2011 year of entry, a similar pattern was seen with stronger associations. Each point increase in the Observance scale was associated with a 22.5% increase in likelihood to pass and 10.3% for the Insight scale. These results seem to confirm the relative importance of the Observance scale in predicting success along with the Insight scale in particular. When we combine these findings with the aforementioned notation that (particularly) the Observance scale correlated more equitably with APS and average mark, we can tentatively conclude that some cognitive aspect measured by this scale may relate better to prediction of both secondary and tertiary schooling results. However, the precise nature of this construct is, at present, unknown.

Clearly these two scales are the most significant in this study when considering the predictive capacity of the PIBSpEEx alone. As was noted in the factor analysis, although the loadings were somewhat low, for a variety of reasons, the Observance scale loaded on a factor alone while the Insight scale loaded on another factor which also incorporated other English based scales (Mental Alertness, Reading Comprehension and Calculations). The fact that the Observance scale, which was intended to be a lower level cognitive visual scale (Erasmus, 2004), language and culture free, reasoning scale, was significant in prediction of

average mark is a point of interest. This scale was actually originally intended for persons without any significant secondary schooling and, usually, the Mental Alertness scale (a poor predictor in this study) should be utilised for those who had obtained Grade 12 certificates (Erasmus, 2004).

The Insight scale on the other hand, consisting of problem solving with words and insight into word reversals, hidden meanings and component parts of words (e.g. Question: They took away the "Y" to turn this lady into a guy; Answer: Lad) (Erasmus, 2004). This scale shows deeper understanding of the component processes at play within word construction and semantics in the English language. From this we may tentatively conclude that since one scale is English based, while the other is based on cognitive-visual differentiation between figures or pictures of objects, the two appear to have the following potential commonalities: 1) fine-detail differentiation (parts of words, missing letters, removal of symbols or addition of symbols); 2) the ability to conceptualise objects in terms of function differentiation (Observance) and abstract meaning (synonym type relationships as in 'guy' and 'lad'); 3) the ability to seek beyond the obvious and identify irregularities or commonalities.

Unfortunately, a lack of research is available on the underlying skills constructing these particular PIBSpEEx scales, since the majority has focused itself on the validity of the instrument in question. However, through this type of analysis, we may find specific inherent cognitive skills, or combinations thereof, are important for the present findings. In this case, reasoning does appear to be an important skill along with attention to detail, ability to differentiate between items and conceptualisation of objects in terms of function (linked to cognitive concept formation).

Should we accept the premise that reasoning and manipulation of information are important, the question arises as to the lack of predictive power of the Mental Alertness scale in particular. Since this scale relied, similarly to Observance, on differentiation between items to identify the item which did not logically belong in a series or group, it seems to lack logical consistency that this scale should demonstrate such disparate performance. Upon consideration of this, English vocabulary skills may be a partial explanation for the lack of consistency. Since the Mental Alertness scale, unlike the Observance scale, is loaded fairly heavily in English language, it may be that poor or inconsistent skills in this area are to blame for the discrepancies noted. Correlation matrices demonstrated a considerably weaker

relationship between Reading Comprehension (as a tentative measure of English language skills) and the Observance scale with stronger relationships with all other scales. However, although this, again, sets the Observance scale apart, it does not explain the better predictive power of the Insight scale as opposed to the Mental Alertness scale. Intuitively, it is understood that while the Insight scale relies heavily on the English language, the focus is more on the manipulation of words and their meanings. Contrarily, the Mental Alertness scale is heavily dependent on precise semantic understanding. The difference may lie in this point.

With regards to the predictive power of the remaining PIBSpEEx scales, although they were not fully analysed within smaller models, examination of the β values produced does yield some insights. In both the 2010 and 2011 years of intake, the Calculations scale produced a negative value. This scale also produced correlation coefficients with average of all marks that were considerably lower than the other scales (albeit significant for the 2011 intake). A similar pattern is seen for the Object Assembly scale, with a β value close to zero and weak, non-significant correlations to average mark. A small discrepancy, similar to that discussed earlier, can be seen with these two scales correlating less well with the stronger predicting scales than with other scales (although the difference is very subtle). It is quite possible that such poorly performing scales could 'drag down' the predictive power of the Total score, partially explaining the large difference evidenced in the logistic regression results.

APS

Utilisation of APS as a predictor of average mark resulted in statistically significant results. However, only around an adjusted 2.9% of variance in average mark in the 2010 intake and 3.7% of variance in average mark in the 2011 intake was explained by differences in APS score. Correlation coefficients of r=.172 and r=.193 were produced. The APS variable was also utilised in a logistic regression model to better understand predictive impact at a simpler pass/fail level. The findings indicated that for the 2010 intake, a point increase in APS was associated with an 8.1% increase in likelihood to pass. For 2011 this was a 6.3% increase in likelihood to pass. Although both of these results were statistically significant, the practical relevance appears questionable. In fact, APS score as a predictor in the logistic regression model performed only marginally better than the PIBSpEEx Total score and worse than some of the individual scales examined.

APS is the most widely used selection criterion and predictor of success in tertiary study as these results purport to indicate levels of general knowledge, academic readiness, thinking ability and knowledge (Cliff & Hanslo, 2009) but do measure prior accomplishment rather than potential (Cliffordson, 2008). It is concerning that so little variance was explained and that the odds of passing did not dramatically increase with points increases in APS value. Setting aside consideration of the PIBSpEEx as part of the selection procedure, it appears APS alone as a criterion is not as valid a prediction of later success as one would hope. There may be a variety of reasons for this: 1) low entry requirements creating a 'skewed' demographic (note APS score was skewed) which are less likely to have a good range of scores (range restriction); 2) students with lower APS scores 'flooding' University of Technology institutions as they fail to meet requirements in other institutions, again creating a restricted range of scores on both variables; 3) lack of validity of the APS criterion as a predictor of tertiary success, either due to lack of representation of the true nature of secondary schooling or due to the secondary schooling system imparting irrelevant skills in terms of tertiary education functioning; 4) factors aside from academic ability proving to be more prevalent in tertiary than secondary education or vice versa (e.g. motivation, English language skills, study skills, family considerations, financial considerations, etc.). Certainly further investigation into this finding is warranted, particularly in light of the relative importance attached to Grade 12 results in selections for tertiary education.

Combined Prediction: APS, Observance Scale and Insight Scale

Since neither the PIBSpEEx nor APS is utilised in isolation for selection purposes, an understanding of the interactive and combined predictive power was essential. For the purposes of maximising prediction and understanding thereof, two approaches to the combined predictive power were taken: 1) Consideration of current selection methods utilising APS and the PIBSpEEx total score; 2) Consideration of the strongest scale predictors as identified through current analyses in combination with APS (since APS is a compulsory variable in the selection procedure).

Summary Of Results.

Initially, a multiple regression model was produced utilising a combination of APS and the PIBSpEEx Total score as predictors. In 2010 this model explained around 4.3% of variance in average mark, a figure which increased to 4.4% in the 2011 year of entry. When examining the relative importance of the two predictors, significant results were obtained for

both years of intake and both predictor variables. APS showed the stronger predictive power in the model, although the PIBSpEEx did not make an insignificant contribution. Clearly the combined predictive power of these two variables is considerably more useful than either alone. However, during the selection process, it would be important to ensure the appropriate weight is allocated to each variable in ensuring relative importance is maintained: a ratio of around 1.453:1 for the 2010 year of entry and around 1.966:1 for the 2011 year of entry with APS carrying the higher weighting. Although we can tentative conclude that both variables play a meaningful role in the selection process, the predictive power of the model and realistic utilisation are both impacted by the utilisation of appropriate selection policies. As discussed earlier, the predictive value of APS was not as strong as expected considering the relative importance designated to this variable in the selection process. Although, with good intention, the PIBSpEEx is designed to provide additional information concerning the potential of low-APS candidates, improper utilisation will conflict with this intention. Currently, at this institution, minimum requirements are set in place and writing of the PIBSpEEx may be compulsory; however, no clear guidelines or policies are utilised regarding application of the results individually or in combination and no quantitative formula is utilised for assigning relative importance or dealing with discrepancies (e.g. low APS with high PIBSpEEx or vice versa). Since, in the selection process, any assessment or criterion is only as useful as its correct application; the results found here are, at least in part, dependent on this issue.

To further investigate potential predictive validity and usefulness of the PIBSpEEx in combination with APS, a second model utilising APS and the previously identified ‘stronger’ scales was created. It was hoped this would bring greater understanding to the predictive power and validity of the PIBSpEEx scale as it currently stands, including the potential for refinement of the battery. Stepwise regression was utilised, entering one predictor variable at a time and observing the Adjusted R^2 value, change in R^2 and change in the model as well as significant levels associated with the entry of each new predictor. As can be recalled from earlier discussions, in the 2010 year of entry the order of priority of the PIBSpEEx scales was Insight, Observance and Conceptualisation. For the 2011 year of entry, the order was Observance, Insight and Reading Comprehension. APS was entered as the first variable in the model since: a) APS generally performed best as a predictor and; b) APS is the initial starting point in the selection procedure. The 2010 model produced a significant result with the introduction of both the Insight and Observance variables (in addition to APS) bringing

significant change. Similar results were observed in the 2011 intake, with the Observance and Insight scales producing significant change. Although these variables did produce significant change in variance explained, they did not, with the exception of the Observance scale for the 2011 intake, act as significant predictors.

The models as a whole explained similar levels of variance to the initial multiple regression model utilising APS and PIBSpEEx Total score. This is of interest, since a number of scales presumed to contribute to the predictive capacity of the variable, it appears, were contributing very little or not at all. As discussed previously, the Calculations scale appeared to operate very poorly in the prediction model, as did the Object Assembly scale. Although it would be presumptuous (and indeed incorrect) to assume either of these scales actually detracted from the predictive power as a whole, they certainly did not seem to meaningfully contribute.

Cognitive Skills, Speededness And English Language Proficiency

Cognitive skills.

In light of the results, the following questions should be addressed: 1) Why do only two specific scales appear to meaningfully contribute to the predictive power of the model?; 2) What differs in the constructs being measured which has created a fair number of 'insignificant' scales in the PIBSpEEx battery and why are they insignificant? and; 3) What can or should be done to improve the predictive power of the model as a whole (including the APS component)? Since the primary focus of this research was an exploration of the predictive power and inter-correlations of these variables, some of these questions, particularly as regards institutional policy and selection procedures, cannot be answered here. However, further theoretical exploration of the specific scales within the PIBSpEEx and the poor predictive capacity of APS can be considered further, particularly in combination.

Although cognitive assessments have long been strongly correlated to schooling success in the past, primarily in developed countries (Neisser, 1997), it is worth noting that wide variation exists in type of cognitive assessment and underlying measurable skills (Anastasi & Urbina, 1997). It has been previously suggested that cognitive skills may develop only in specific contexts and their effects on education may be masked by differences in socio-economic status, quality of schooling and other factors (Wagner, 1978). However, certain skills may be 'released' by appropriate education, potentially providing a conceptual link between underlying cognitive ability and its ability to predict educational

outcomes. In addition, improvement in academic results following study skills improvement has been linked to increased meta-cognitive skills and problem solving styles (Villares, Frain, Brigman, Webb, & Peluso, 2012).

Since the PIBSpEEx purports to measure underlying skill sets, free of schooling (albeit not free of cognitive processes required for successful secondary schooling), a logical path of enquiry leads to the question of what cognitive constructs are important for secondary and tertiary study but are not necessarily formally examinable in terms of achievement outcomes. Secondly, the question of whether or not these constructs can, and should, be improved through the secondary education system, and early childhood developmental programmes. Since the Observance and Insight scales (albeit tentatively) appear to be higher functioning variables within the PIBSpEEx battery, investigation of this relationship should almost certainly begin there. As indicated previously, both these scales appear to deal with the capacity to draw conclusions from observation, often in a detailed, complex manner as well as logical reasoning and abstract conceptualisation. Unlike certain other scales (e.g. Conceptualisation, which, for interest's sake, was only a fractionally weaker predictor), the Observance scale does not rely heavily on the learning of a new skill since, a) the concept of the 'odd one out' had been previously taught during the Mental Alertness assessment and b) no unusual or out of context language was utilised. Therefore, this scale may be less of a measure of learning potential in terms of identification of new processes, syntheses and solutions than some other scales (e.g. Conceptualisation, also identified as a stronger scale in 2010).

It can certainly be reasonably hypothesised that cognitive processes such as attention to detail, logical reasoning, inference of missing information and reasoning or abstraction through focused attention are important for tertiary study. International studies have noted similar relationships utilising a variety of cognitive and reasoning assessments, particularly involving reasoning utilising some form of symbol system in non-verbal assessments (Lohman, 2005) in the prediction of later academic success. The PIBSpEEx, like other cognitive assessments, purports to utilise the ability to grasp new skills and concepts (Erasmus, 2004), focusing on problem solving and reasoning to better understand potential for academic success, amongst other areas (Matarazzo, 1972; Sternberg & Pretz, 2005). Focusing specifically on the skills required for success in the Observance and Insight scales, we can see the value of these constructs in success, particularly problem solving, reasoning and concept formation. In the case of the Insight scale, knowledge and comprehension of

semantics as a pertinent factor in success does not appear as prominent as in (for example) the Mental Alertness scale or, indeed, Calculations scale. Since the scale primarily consists of reasoning utilising deduction, inferences, reconstruction of words and letters and in-depth interpretation of the consequences of reversals and re-arrangements, it appears that these are more important skills which are relatable to the skills mentioned earlier.

Understanding of the cognitive and meta-cognitive skill sets as a result of an exploratory study such as this is almost impossible. It does seem that many of the skills present appear to be relatable to assessments of working memory and meta-cognitive monitoring which may provide a common denominator. However, it is important to note that the two identified scales, aside from having certain cognitive process commonalities, also had a second factor in common: Students generally finished these scales fairly easily within the time limit. This leads to the question and role of test speededness in psychometric testing and the importance of 'quick' response rates for predicting educational success and in the interpretation of cognitive ability.

Speededness.

Another potential (partial) explanation for the improved predictive capacity of the Observance and Insight scales regards speed and time limit considerations. Observation of the testing processes indicated that for both these scales students were able to finish all questions well within the time limit (this is not true of the majority of other scales with the exception of Reading Comprehension, also identified as a better functioning predictor). Studies on the Scholastic Aptitude Test, utilised in the United States of America for college entry, indicated that additional time was only advantageous to lower ability students and, even then, only up to a limited point, after which the length of testing without breaks made it disadvantageous (Mandinach, Bridgeman, Cahalan-Laitusis, & Trapani, 2005). However, in an examination of a specific cognitive assessment, a Canadian study found that removal of time limits improved performance. This was most marked in students with poor understanding of the language in which the assessment was conducted (Mullane & McKelvie, 2001). Given that the majority of the students did not cite English as their home language, it is certainly possible that a combination of poor English skills or forward and back translation during the assessment along with the strict time limits impacted the assessment results, particularly for the more poorly operating scales (Mental Alertness, Calculations, etc.).

The role of English language.

A final area which bears short discussion in light of these results is the role of English language skills in secondary schooling, performance on the PIBSpEEx and tertiary results. Generally, Grade 12 examinable material is fairly loaded on English language skills, with the exception of language specific papers. The PIBSpEEx purports to assess functionality in cognitive skill, therefore instructions and tests are presented in English. The language of learning in tertiary education at this particular institution is exclusively English. From this alone, it is reasonable to conclude that the English language skills of the student have bearing on later success. If language of instruction is used, throughout schooling, to construct cognitive concepts and skills, it is clear that lack of proficiency in such a language (or proficiency being acquired in a different language) will impact schooling results (Cantoni, 2007). However, the two concepts are interlinked, whereby improvement in literacy and reading is often tied to improvement of cognitive and metacognitive skills including awareness, monitoring and regulating (Torgerson, 2007). Therefore, it is almost impossible to disentangle the effects of English proficiency and cognitive ability, perhaps a problem evidenced in difficulties in producing and understanding culture and language fair testing even utilising non-verbal assessments.

The impact of English skills on the PIBSpEEx assessment and other facets was, in this study, relatively unknown since English proficiency was not directly measured. It could be noted that scales requiring more complex understanding of vocabulary or meaning (e.g. Mental Alertness, word problems in Calculations) provided weaker correlations with both APS and average mark. This is a curious artefact since one would expect that if a scale were loaded in English and study was loaded in English a common denominator would provide a stronger relationship. From this it appears fairly clear that other factors are at play in success during studies although English language may be a limiting or overarching factor.

Although the PIBSpEEx appears to be useful as an addition to this information, better predictive ability and fuller understanding of the aforementioned constructs potentially underlying success, at least in part, is surely useful to improving the predictive power of selection processes.

Chapter 6: Limitations

Data

Many of the limitations in this study were due to availability and type of data. In any large scale institutional study, provision of data, data cleanliness and other such concerns become paramount. Reasons for missing or unrepresentative data were manifold and are outlined below, along with some ways in which this study dealt with this eventuality.

Multiple Imputation And Missing Data

The purpose of multiple imputations is the dealing with of missing values (whether through non-response in surveys, missing data, etc.). This has the advantage of imputing *m* number of missing values (in this case five) thereby creating *m* number of completed data sets. Multiple imputation has the advantage of creating more the one complete data set so that a) standard statistical procedures which were not available for the incomplete data can be utilised and; b) comparative analysis of the plausible values within each data set can be considered as theoretical possibilities by incorporating the researcher's unique knowledge (Rubin, 1987). In the case of this study, multiple imputations (within specific value constraints) were essential due to the large amount of missing data. As previously mentioned, this data was missing for one of three reasons: 1) students did not write the PIBSpEEx but were accepted; 2) students wrote the PIBSpEEx but were not accepted and; 3) the ever-present possibility in any large institution of missing data due to errors, technical problems or other causes.

Regardless of the reasons behind the missing data, the multiple imputation method was utilised to complete the data sets and allow analyses. However, this method imposes a variety of constraints and limitations on a study. The first limitation involves the accuracy of the representation of the missing data. Fortunately, although full accuracy can never be achieved, it is more important that the imputation model fits those aspects of the distribution relevant to the analysis model and act (note, not necessarily look) like the observed variable when analysed (von Hippel, 2012). However, although multiple imputations are useful, it will still be subject to sampling variability (Rubin, 1988). Multiply imputed values cannot necessarily be treated as 'real' values for two reasons: 1) since they are proxy values and predicted they are subject to measurement error, and; 2) they introduce uncertainty beyond sampling variation in the original data (Mittag, 2013).

Overall, multiple imputation is a useful method for dealing with missing data, particularly when the missing data mechanism or cause is not ignorable and the imputations

may contain information which corrects the cause of the missing information (in this case, incomplete records) (Mittag, 2013).

Sample Size And Statistical Significance

The samples in this particular study were fairly large. Although this does improve the generalizability of findings, it can introduce an additional set of difficulties. With larger sample sizes, very small differences are often found to be statistically significant (Howitt & Cramer, 2011). This was evidenced in this study through results significant at the 1% level with fairly small effect sizes. Statistical significance is merely a way of quantifying strength of evidence and the issue of sample size and likelihood of significance has been subject to a variety of debates and hypotheses, including those centering around practical significance and odds ratios as well as effect sizes (Royall, 1986). The impact of a larger sample on likelihood of significance cannot be ignored and, therefore, the results in their entirety, inclusive of composite models, effect sizes and odds ratio analyses should be considered carefully, rather than a simple examination of significance level.

Range Restriction

The sample in this study was somewhat subject to range restriction issues for a variety of reasons, primarily due to lower entry requirements allowing students entry while higher requirements at other universities denied them entry creating a specific cohort of accepted students within a specific APS range and resulting in the APS variable being skewed. Although this was corrected through transformation for analysis, the exclusion of a large cohort of potential students (i.e. higher APS with higher achievement) is certainly likely to have weakened the study as a whole, potentially reducing correlational strength (Hair, Anderson, & Tatham, 1987).

Outcome Variable (Average Mark)

In this study, the dependent variable consisted of the average mark obtained overall all years of study. Therefore, for the 2010 intake a larger number of marks contributed to the final mark than in the 2011 intake. The average mark obtained from the institutional data covered all marks obtained including repeated subjects, previously failed subjects and did not discriminate as to whether students were taking some first year and some second year subjects. It would have lent strength to this study to have separate data sets per year of study, repeats, and so on. However, due to differential numbers of subjects taken, repeats of first year subjects in combination with other second year subjects and some students not taking

full course loads each year, this proved somewhat intractable. It is possible that the predictor variables would have behaved differently per level of mark, for specific subject marks or for repeated subjects. In addition, it would have been possible that specific Grade 12 subject combinations may have behaved differently as predictors if considered separately rather than as part of a total APS value. However, such differentiations were somewhat beyond the scope of this study, although they are worth noting.

Exits From Studies

A portion of the sample (or potential sample) would have been missing or non-viable due to exits from studies in first year or earlier. As was noted during the literature review, a number of reasons exist for exiting studies including academic failure, failure to meet financial or home commitments, deliberate exit to change courses or institutions and deliberate exit to enter the world of work. Therefore, students exiting the institution or specific courses did not necessarily do so due to academic non-performance. This did create an inconsistency in terms of available data, since for some students only first year results were available or several sets of first year results were available if the student changed courses. This would have impacted general averages obtained, particularly if the student repeatedly failed and switched courses or left due to academic reasons, leaving behind only a fail average.

Sample Composition

Demographic Composition

The demographic composition of the sample, as a reflection of the institution, was somewhat skewed with Black students of various ethnicities forming the vast majority followed by White students and small intakes of coloured and Indian students. Although this does reflect the national average in terms of choice of type of institution (Fisher & Scott, 2011), it was found that APS, average mark and the PIBSpEEx demonstrated higher values for White students, particularly Afrikaans students. The institution in question offers a number of highly specialised courses which were included in this study, including Dental Technology and Medical Orthotics and Prosthetics. A cursory examination did reveal that these courses were subject to higher entry requirements (Prospectus 2011, 2011) (note APS correlation with PIBSpEEx) and required the writing of the PIBSpEEx for all applicants. In addition, these courses admitted proportionately more White students. Firstly, the implications here are twofold – the correlations found and predictive validity, particularly of APS, may operate

difficulty when higher brackets of APS are introduced. Secondly, the entry demographic would have been skewed by increased entry requirements for courses in which White students are more likely to enrol. However, despite the unequal nature of the sample, it does generally reflect the composition of the South African population as a whole, which does improve potential generalisability, although not to University entrance populations.

Categorical Differentiation

The bursary or finance variable was subject to limitation in terms of differentiation. The variable, as it stood, combined merit bursaries of a variety of types along with NSFAS funding. Obviously, NSFAS funding is subject to somewhat different requirements to the obtaining of a merit bursary. Since these types were not separated, it is possible that the results obtained were affected in some way. It would have lent strength to this analysis to separate bursaries obtained on merit or through private enterprise from NSFAS funding in the form of a loan, which has less stringent requirements for allocation.

Language Bias

The issue of language bias was considered during the results and discussions chapter, and will therefore only be mentioned here as a limitation. The majority of the sample did not indicate English as their first language and, therefore, studies, exams and the PIBSpEEx being presented and focused on English language usage will most probably have been subject to some form of influence. Although this has been discussed more thoroughly elsewhere, here suffice to note that language issues most probably did have an impact on the predictive power of these variables and will, most probably, impact general tertiary study and success rates in South Africa.

Chapter 7: Conclusion and Recommendations

Based on the results of this study, it appears that the PIBSpEEx does contribute significantly to a base predictor of APS value in predicting average mark in tertiary study at a University of Technology. Despite limitations and relatively small effect sizes, it appears that cognitive assessments may be a valuable adjunct to the traditional Grade 12 results in selecting high potential students who are likely to succeed in National Diploma courses. Particularly, it was found that specific scales within the PIBSpEEx are more valuable in prediction of success, as confirmed by stepwise and linear regression models. These results and their concomitant limitations lead to a number of recommendations for further research.

Firstly, it seems prudent to investigate the relatively low predictive power of Grade 12 results, particularly with regards to the specific predictive value of actual subjects as opposed to the score as a whole. It would be prudent to do so utilising a wider range of APS values, in a larger scale study across various Universities of Technology. It may also be valuable to investigate potential differences in predictive power between Universities of Technology and Academic Universities, taking into account differences in ethnic composition and family socio-economic status of students. In addition, it would be useful to attempt to discern differences in predictive power with regards to more specific subject scores, potential exiting students and taking into account subject repetition and course load.

Secondly, as regards the PIBSpEEx, a study comprising of a more complete sample, not subject to the potential limitations of multiple imputation, would provide valuable insights into the potential predictive validity of the instrument in combination with APS. Increased research into the underlying constructs measured, particularly by the Observance and Insight scales, would be valuable in understanding underlying skills essential for tertiary study. Attention in this area, particularly as regards underlying cognitive skills as a predictor of success, would be valuable to better understanding of poor success rates in higher education.

Thirdly, investigation into the role of English language skills would be essential to better understanding of prediction. Although English is assessed in Grade 12, the composition and skill set of this assessment may provide opportunities for rote learning. Probing into basic English language ability in terms of vocabulary, sentence construction and ability to infer meaning from language and apply language to specific concepts and situations would be valuable in better understanding this relationship. A fuller understanding here would be beneficial to understanding the predictive power of APS, particularly in English unique

subjects such as mathematics (in which certain concepts are known only English and no other language, thereby inhibiting backward-forward translation of concepts). In addition, certain cognitive constructs in which assessment is based in English (here for functional purposes) may not be subject to backward-forward translation and could therefore be investigated more closely. Additionally, as mentioned previously, the issue of time-limits in both cognitive and achievement assessments could be further pursued, particularly in relation to students for whom English is a second or even third language.

Generally speaking, given the difficulties South Africa faces in tertiary through-put rates and high drop outs and numbers of failing students at tertiary level, investigation into predictors of success (cognitive and otherwise) and improvement of selection procedures is essential. Although promotion of mass participation was valuable and necessary for skill improvement within the country, at present the tertiary education situation is in both financial and academic crisis. More stringent, comprehensive selection procedures alongside more effective streaming of students into trade and Further Education and Training colleges, Universities of Technology, Comprehensives and Academic Universities would most probably provide some benefit. In order to effectively do so, selection instruments which provide additional information to that gained by APS values should be further investigated.

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Appendices

Appendix 1

Kriel's (2002) Results of Multiple Regression analysis n=106 for Criterion Validity of the PIBSpEEx in an Academic Institution.

Criterion	*Predictors*	*Multiple R*	R^2	*F Ratio*	*Standard Error of the Estimate*
Food Technology	Advanced Calculations Assembling (Advanced) Insight Environmental Exposure	0.68	0.46	0.00**	12.05
Process Technology	Insight Environmental Exposure Reading Comprehension	0.64	0.41	0.03*	6.77
Physics	Advanced Calculations Environmental Exposure	0.45	0.21	0.02*	11.76
Computer Skills	Observance Conceptualisation Perception	0.48	0.24	0.00**	14.15
Analytical Chemistry	Observance Conceptualisation Environmental Exposure	0.64	0.41	0.00**	14.15
Microbiology	Conceptualisation Observance Insight	0.34	0.12	0.04*	8.34
Chemistry	Insight	0.40	0.16	0.02*	7.66
Calculations & Statistics	Advanced Calculations Environmental Exposure Comparisons Conceptualisation	0.57	0.32	0.00**	11.17

** Statistically significant at the .05 level*
*** Statistically significant at the .01 level*

Appendix 2

PIBSpEEx scales descriptive statistics

Pooled Data		*Min*	*Max*	*Mean*	*Std. Deviation*	*Skewness*		*Kurtosis*	
						Statistic	*Std. Error*	*Statistic*	*Std. Error*
2010 Intake	Conceptualisation	1.020	9.600	5.008	1.321	0.061	0.039	-0.107	0.078
	Mental Alertness	1.000	9.300	4.333	1.342	0.115	0.039	-0.170	0.078
	Observance	2.540	9.640	6.201	0.976	0.010	0.039	-0.031	0.078
	Insight	1.000	9.460	4.153	1.511	0.212	0.039	-0.264	0.078
	Verbal Reasoning	8.760	32.260	19.695	3.574	0.127	0.039	-0.142	0.078
	Calculations	1.000	6.920	3.200	1.024	0.228	0.039	-0.205	0.078
	Object Assembly	1.000	10.000	4.454	1.940	0.356	0.039	-0.441	0.078
	Non Verbal Reasoning	2.120	15.480	7.654	2.364	0.312	0.039	-0.274	0.078
	Reading Comprehension	1.000	9.900	4.628	1.530	0.156	0.039	-0.254	0.078
	Language Score	1.000	9.900	4.628	1.530	0.156	0.039	-0.254	0.078
	PIBSpEEx Total	21.000	42.000	33.517	6.022	-0.541	0.434	-0.369	0.845
2011 Intake	Conceptualisation	1.000	10.000	4.997	1.336	0.070	0.036	-0.115	0.073
	Mental Alertness	1.000	9.220	4.352	1.330	0.071	0.036	-0.235	0.073
	Observance	1.000	10.000	6.148	0.999	-0.135	0.036	0.762	0.073
	Insight	1.000	10.000	4.251	1.573	0.490	0.036	0.387	0.073
	Verbal Reasoning	8.000	33.060	19.747	3.663	0.228	0.036	0.048	0.073
	Calculations	1.000	8.000	3.173	1.026	0.235	0.036	-0.028	0.073
	Object Assembly	1.000	10.000	4.398	1.949	0.360	0.036	-0.445	0.073
	Non Verbal Reasoning	2.000	15.440	7.571	2.414	0.330	0.036	-0.261	0.073
	Reading Comprehension	1.000	9.900	4.640	1.576	0.123	0.036	-0.286	0.073
	Language Score	1.000	9.900	4.640	1.576	0.123	0.036	-0.286	0.073
	PIBSpEEx Total	12.000	53.000	33.114	7.003	0.150	0.080	-0.099	0.161

Appendix 3

Demographic differences in PIBSpEEx scales 2010 intake: Independent samples T-Tests

Scale	*Demographic*	*t*	*p*	*M difference*	*Category of higher mean*	*d*	*d Size class*	*Approx. PS*
Conceptualisation	Gender	1.152	.257	0.060	Female	0.045	Small	51
	Residence	-0.627	.543	0.045	Residence	0.035	Small	51
	Bursary	-1.039	.307	0.055	Bursary	0.047	Small	51
Mental Alertness	Gender	0.557	.591	0.040	Female	0.031	Small	51
	Residence	-0.431	.668	0.230	Residence	0.017	Small	50
	Bursary	-0.413	.682	0.022	Bursary	0.015	Small	50
Observance	Gender	0.497	.622	0.019	Female	0.021	Small	50
	Residence	-0.569	.576	0.260	Residence	0.026	Small	50
	Bursary	-0.919	.366	0.036	Bursary	0.042	Small	51
Insight	Gender	0.698	.502	0.057	Female	0.040	Small	51
	Residence	-0.947	.352	0.061	Residence	0.041	Small	51
	Bursary	-1.264	.237	0.102	Bursary	0.068	Small	52
Calculations	Gender	0.049	.962	0.003	Female	0.000	Small	50
	Residence	-0.718	.480	0.032	Residence	0.031	Small	51
	Bursary	-0.948	.354	0.040	Bursary	0.040	Small	51
Object Assembly	Gender	0.680	.513	0.070	Female	0.037	Small	51
	Residence	-1.041	.311	0.091	Residence	0.048	Small	51
	Bursary	-0.893	.393	0.088	Bursary	0.050	Small	51
Reading Comprehension	Gender	0.666	.525	0.063	Female	0.040	Small	51
	Residence	-0.277	.784	0.190	Residence	0.013	Small	50
	Bursary	-0.537	.601	0.042	Bursary	0.027	Small	50
Total Scale	Gender	1.100	.292	0.312	Female	0.054	Small	51
	Residence	-1.314	.193	0.296	Residence	0.051	Small	51
	Bursary	-1.908	.058	0.385	Bursary	0.068	Small	52

Demographic differences in PIBSpEEx scales 2011 intake: Independent samples T-Tests

Scale	*Demographic*	*t*	*p*	*M difference*	*Category of higher mean*	*d*	*d Size class*	*Approx. PS*
Conceptualisation	Gender	-0.798	.426	0.034	Male	0.022	Small	50
	Residence	0.508	.617	0.028	Off Campus	0.022	Small	50
	Bursary	1.212	.247	0.075	None	0.052	Small	51
Mental Alertness	Gender	1.108	.279	0.057	Female	0.045	Small	51
	Residence	0.949	.362	0.062	Off Campus	0.045	Small	51
	Bursary	-0.253	.803	0.014	Bursary	0.015	Small	50
Observance	Gender	0.595	.554	0.021	Female	0.020	Small	50
	Residence	-1.333	.192	0.052	Residence	0.050	Small	51
	Bursary	-0.766	.461	0.039	Bursary	0.039	Small	51
Insight	Gender	0.127	.900	0.007	Female	0.000	Small	50
	Residence	1.756	.081	0.094	Off Campus	0.056	Small	51
	Bursary	1.228	.224	0.069	None	0.043	Small	51
Calculations	Gender	-1.689	.100	0.063	Male	0.070	Small	52
	Residence	1.576	.117	0.055	Off Campus	0.048	Small	51
	Bursary	0.485	.628	0.017	None	0.010	Small	50
Object Assembly	Gender	-0.087	.931	0.006	Male	0.000	Small	50
	Residence	0.627	.547	0.068	Off Campus	0.036	Small	51
	Bursary	0.357	.725	0.029	None	0.015	Small	50
Reading Comprehension	Gender	0.259	.798	0.016	Female	0.013	Small	50
	Residence	-0.209	.839	0.016	Residence	0.013	Small	50
	Bursary	-0.737	.465	0.043	Bursary	0.032	Small	51
Total Scale	Gender	-.010	.992	-.00213	Male	0.000	Small	50
	Residence	.760	.466	.23918	Off Campus	0.038	Small	51
	Bursary	.337	.741	.09422	None	0.015	Small	50

Appendix 4

Demographic differences in PIBSpEEx scales 2010 intake: ANOVA

Scale	*Demographic*	*F*	*d.f.*	*p*
Conceptualisation	Ethnicity	0.914	11.833	.555
	Home Language	0.966	12.667	.510
Mental Alertness	Ethnicity	1.570	11.833	.418
	Home Language	1.499	12.667	.316
Observance	Ethnicity	1.461	11.833	.464
	Home Language	1.695	12.667	.499
Insight	Ethnicity	1.822	11.833	.266
	Home Language	1.877	12.667	.401
Calculations	Ethnicity	1.460	11.833	.250
	Home Language	1.583	12.667	.455
Object Assembly	Ethnicity	1.263	11.833	.319
	Home Language	1.629	12.667	.227
Reading Comprehension	Ethnicity	2.011	11.833	.332
	Home Language	1.401	12.667	.390
Total Scale	Ethnicity	1.341	11.833	.389
	Home Language	1.137	12.667	.474

Note: No partial η^2 or PS values were calculated due to the lack of significant differences; All results refer to standard ANOVA F

Demographic differences in PIBSpEEx scales 2011 intake: ANOVA

Scale	*Demographic*	*F*	*d.f.1*	*d.f.2*	*p*	*Partial* η^2	*Approx. PS*
Conceptualisation	Ethnicity	4.908	13	1231	.000	0.009	55
	Home Language	4.852	14	650	.000	0.006	54
Mental Alertness	Ethnicity	4.657	13		.000	0.009	55
	Home Language	4.016	14		.000	0.008	55
Observance	Ethnicity	4.196	13	744	.000	0.015	57
	Home Language	4.087	14	342	.000	0.017	57
Insight	Ethnicity	7.197	13	881	.000	0.015	57
	Home Language	5.697	14	439	.000	0.007	54
Calculations	Ethnicity	3.835	13	846	.000	0.010	56
	Home Language	3.551	14	806	.000	0.007	54
Object Assembly	Ethnicity	4.275	13		.000	0.014	57
	Home Language	3.178	14		.002	0.010	56
Reading Comprehension	Ethnicity	3.119	13		.001	0.012	57
	Home Language	2.072	14	505	.077	0.008	55
Total Scale	Ethnicity	8.3033768	13	737	.000	0.017	57
	Home Language	6.650	14	455	.000	0.009	55

Note: d.f. 1 is reported for between-groups ANOVA F;
d.f.1 and d.f.2 are reported for Brown-Forsythe F pooled result as whole numbers