AN INVESTIGATION OF THE USE OF NBTs IN PLACEMENT OF FIRST YEAR STUDENTS IN SCIENCES

Melanie Jacobs
University of Johannesburg
South Africa
melaniej@uj.ac.za

ABSTRACT – This paper reports on an investigation into the National Benchmark Test (NBT) as predictor and placement instrument of first year students in Science and Engineering programmes. The NBT consist of two tests: an Academic and Quantitative Literacy test as well as the Mathematics test and determines students' readiness for higher education. In contrast the school leaving examination determines if the school leaver achieved a pass in the Grade 12 examination. This research reports on academic performance of first-year Science and Engineering students at the University of Johannesburg from 2012 to 2014. The data set contains the school profile (National Senior Certificate results and NBT results) compared with the university results in gateway modules such as Mathematics, Chemistry and Physics at first year level. The research question for this paper is: Does the NBT score provide predictive value to place first year students in Science modules?

The investigation measured the predictive value of the APS (as a measure of the Gr 12 result) and the NBT results towards performance in university modules in Mathematics, Chemistry and Physics at first year level. The relationship between performance in the Grade 12 and the NBT Mathematics test toward specific first-year modules was examined by means of hierarchical multiple regression analyses. The analysis provide evidence that the NBT can make a contribution towards predicting success and should be considered as a diagnostic instrument.

The findings indicate that variance greater than 25% can be explained by the Grade 12 and the NBT Mathematics results and should be applied when students arrive at institutions. Knowing before the first university assessment that students would seek support and more attention should assist students before they drop-out or fail. Institutions could apply this knowledge to suggest various intervention of which placing students in appropriate programmes or support structures are but a few suggestions.

Keywords: *Admission requirements, Academic performance; Academic proficiency; National Benchmark Test (NBT); Placement.*

1. PURPOSE AND CONTEXT OF THE RESEARCH

A new cohort of first year students has entered higher education in 2015, after the introduction of the Curriculum Assessment Policy Statements (CAPS) from 2012. This specific investigation interrogates the results from entering students at a South African university who have completed the previous curriculum known as the National Curriculum Statement (NSC). This paper serves as the first report and a follow-up study at the end of 2015 will then compare results with a similar study with students entering with the CAPS. The national school curriculum changes has definite impact on the university curriculum in various disciplines but this research places a lens on Mathematics, Chemistry and Physics performance at first year level.

Changes in school curriculum influences all programmes in higher education and programmes such as Law, Humanities, Management and Arts will all rely on English writing and reading ability. However, in Sciences, Engineering and Accounting the school Mathematics and Physical Science form the fundamental content knowledge and skills from where the university curriculum should progress. Internationally, universities have been challenged with underprepared students entering higher education. In an investigation by d'Hombres (2007), it was found that the graduation rate for the cohort of 2000 (in all disciplines) was 33.2% in the USA, 24.6% in France and 19.3% in Germany. The graduation rates appeared better in Finland (40.7%), United Kingdom (37.5%) and Australia (36.3%). The South African (SA) study by Bunting (2008) showed that of the 2000 cohort (120 000 students entered), 25% graduated in the minimum time and another 40% graduated within an additional three years.

Prof Ian Scott has indicated that the graduation rate of Science students in SA is alarmingly low, with fewer than one in five (in fact only 23%) completing their three-year studies in that time (CHE, 2013). Fewer than four in ten (23%) complete the four-year professional degree (e.g. BIng) in that time, only 5% diploma students in Science graduate in time and only 14% of Engineering diploma students in minimum time. Participation of Black students in Science, Engineering and Technology (SET) programmes (at 12%) increased slightly over the past few years, but still only one out of every three Black students graduate within five years (Scott, 2007). First year students in the SET programmes will rely on content knowledge and skills embedded and supposedly provided in school.

The purpose of this study is to focus on the value that the NBT, in conjunction with the school results, can add to the admission and placement strategies of Science and Engineering programmes. This study investigates the predictive value of NSC results (with additional information added from the NBT results) and will report on the cohorts from 2010 to 2014. The research question for this paper is: Does the NBT score provide predictive value to place first year students in Science modules? The purpose is to provide evidence towards the use of NBTs with NSC results to inform placement strategies as this will also inform the future study into the 2015 cohort entering with the CAPS.

The *first goal* of this study is to determine the predictive value of the APS (as a measure of the Gr 12 result) towards performance in university modules in Mathematics, Chemistry and Physics at first year level. The *second goal* is to explore the value that the NBT-score of each student contribute toward predicting performance in the aforementioned in university modules. The author intends to deduce a set of recommendations aimed at placement strategies for first year Science and Engineering students.

2. LITERATURE PERSPECTIVES

2.1. Theoretical framework

University committees and ultimately the Senate, the highest decision-making body within an institution, determine the admission requirements and policies that govern the level required for students to enter the set programmes. Universities are challenged to admit students in undergraduate programmes based on school-leaving results and are continuously made aware that admission policies should not be used to exclude students (DoE, 2008b and CHE, 2013). The 2014 admission requirements at most SA universities were based on the National Senior Certificate (Wits, 2013; UP, 2014, and UJ, 2014) and were formulated to admit students who showed previous success (adhering to the requirements) and had the greatest potential to complete their studies with success. The studies of Scott (CHE, 2013) and Bunting (2008) indicated that although students adhere to the requirements only 25% would possibly graduate in the minimum time and the other 75% will be at risk to drop out or to take much longer to complete.

In a study by Thompson and Kobrak (1983) they investigated the prediction of the success of students and suggested to take accept any person but needed to assess the students to determine which students would be at risk to perform unsatisfactorily. The study emphasised that these at-risk students use the resources which could benefit more deserving students and consume disproportionate time of lecturing staff. Furthermore, the researchers warned that lecturers often lower the expectations to fit these students. A study by Nelson, Nelson and Malone (2000) set out to predict models that could serve institutions to select students who are most likely to succeed university studies. This particular study compared different academic disciplines and although different skills and knowledge was required for certain disciplines it considered the predictive validity of the graduate grade point average (GGPA) used in the United States and found variations in the coefficients of correlation between different disciplines. Nelson, et.al (2000) provided evidence that the discipline in itself acted as a predictor of success and used completion rate as the measure for success.

In a contextualised South African study, Wilson-Strydom (2012) documents the placement practices and use of the NBTs at the University of the Free State (UFS). The study indicates the use of the NBTs for placement purposes since 2010 and Rankin; Schöer; Sebastiao, and van Walbeck (2012) found that a combination of NCS and NBT results has predictive value of performance in university modules. The author has investigated placement in Science programmes in South Africa (Jacobs, 2010 and Jacobs, De Bruin, Van Tonder and Viljoen, 2015) and has suggested that an alternative measure of prediction of academic success be implemented.

The author is making the assumption that students will apply to universities with the CAPS results and admitted if those results adhere to the admission requirement. However, the value of the NBT cannot be underestimated and therefore this study suggests that school results are used in conjunction with the NBT results. The combination could serve as a diagnostic instrument to identify areas of risk and place students in intervention programmes and render support from the beginning of their studies. The predictive model of Nelson, Nelson and Malone (2000) will serve as the theoretical lenses through which this specific study is viewed.

2.2. Reflection on the South African Grade 12 results

According to the DoE (2008a), 2008 was a year of "…enormous significance for education …" in SA since the last Senior Certificate (SC) examinations were written by Grade 12 learners in 2007. The new National Curriculum Statement (NCS) provided learners with a National Senior Certificate (NSC) and was introduced in Grade 10 (from 2006). The CAPS was introduced in 2012 and a new cohort entered universities in the beginning of 2015 (DBE, 2011). One disconcerting issue is the fact that in 2007 there were 920 716 learners in Grade 11, of which only 533 561 (58%) entered Grade 12 in 2008, with only 588 643 learners eventually registering for the Grade 12 examination in November 2008 (RSA DoE, 2008b).

In Table 1 (in the addendum), an analysis of the 2006 to 2009 Grade 12-results of Mathematics and Physical Science specifically can be found focused on the NSC candidates. From 2001 to 2007 the average Higher Grade pass for Mathematics ranged between 6.7% and 7.6% (Brombacher, 2004 and Volmink, 2010). In 2008 and 2009 the learners passing the equivalent level increased to 19.8% and 15.8% respectively. This increase provided more students access to university programmes where these specific subjects serve as admission requirements.

In a further analysis of the 2010 to 2013 Grade 12-results in Table 2 (see addendum) the increase in the pass rate (67.8% in 2010 to 78.2% in 2013) is certainly a reason for celebration with more than a million learners in Grade 12. However, based on the trend presented in Table 1 about 17% passed Mathematics above 50% and the best scenario 11% above 60% (in 2013, 15 693 learners qualified for SETH and Business programmes). Alarming figures in Table 2 show that only 52% of learners in Grade 12 actually wrote Grade 12 (in 2013); the calculated throughput is indeed increased with

33.9% (2010); 35.2% (2011); 36.3% (2012) and 40.2% (2013). The learners passing Mathematics are less than 150 000 and more than 20% passed with 50% and above (Spaull, 2014).

2.3. Mathematics crisis in South African secondary school curriculum

Just focusing on Mathematics in the school curriculum is essential to predict where higher education will be going within the next few years. This section will place a lens on the enrolment figures and quality of Mathematics which has been a barometer for Science, Health Sciences, Engineering and Accountancy programmes.

The NSC provided the opportunity to terminate the options of higher grade and standard grade options in school subjects and also brought about a new subject namely, Mathematics Literacy. As the NSC allows for learners to choose between Mathematics and Mathematical Literacy, in itself a positive development, as all learners would have some Mathematics background. Since 2008 more students enrolled for Mathematical Literacy (25% Gr 12 learners in 2013) with a decline in Mathematics enrolments (Compare almost 300 000 in 2009 in Table 1 in addendum). In 2008, 56% enrolled for Mathematics, 2010 declined to 49%, in 2013 it was 43%. The fact that there is a decline in learners in Mathematics raises a problem as the total enrolments are steadily rising (Table 2).

Since 1995, SA participated in the Trends in Mathematics and Science Study (TIMSS) measuring achievement against other middle-income countries. In 1995, the Gr 8 Mathematics score for SA was 276th out of the possible 500, and 260th out of 500 for Natural Science. In 2002, SA scored 264/500 (Gr 8) and 285/500 (Gr 9) for Mathematics and 244/500 (Gr 8) and 268/500 (Gr 9) Science. The situation worsened dramatically in 2011 with Gr 8 Mathematics positioned at 433/500 and Science at 443/500 place (Spaull, 2014) SA did not improve in Gr 8 Mathematics between 1995 and 2002; there was a substantial improvement in Gr 9 Mathematics between 2002 and 2011 but according to the report (TIMSS, 2012) the average Gr 9 is two years of learning behind the average Gr 8 learner from 21 other middle-income countries and 2.8 years behind in Science. In the 2013 report, SA was placed last out of 50 participating countries.

The Department of Basic Education (DBE) has started measurement against itself with the Annual National Assessments (ANAs), testing Literacy and Numeracy competency and the results pointed to alarmingly low levels of achievement. The DBE tested over 7 million learners from Gr 1 to Gr 6 and then again in Gr 9 with the purpose of improving the quality of performance in the system of basic education. The 2013 report exposed weak results in language and mathematics in all the grades where the qualitative analysis suggests "… that most learners have not mastered knowledge and skills that are appropriate to the grade in which they are placed." The National School Effectiveness Study (NSES) (Taylor, 2011) followed 15 000 learners in 255 schools and tested Gr 3 content such as "24÷ 3" where only 16% learners in Quintile 1 (lowest socio-economic environment) schools had it correct and 60% still had it wrong after Grade 5 (Spaull, 2014). In the Quintile 3 schools, only 17% learners had it correct in Gr 3, and 57% still had it wrong in Gr 5. In the Quintile 5 (highest socio-economic environment) schools 39% learners in Gr 3 had it correct and 33% still had it wrong in Gr 5.

In the above study (Taylor, 2011) it is argued that low quality of education "traps" the learners and prohibit poor children to move on and become competitive in the labour market. This study highlights the effective management of the schools and covering of the curriculum. The problems that learners have can be influenced by many conditions and a remedy for the national problem will not be found in a boardroom or policy. Spaull (2014) sheds light on the Study of the Conditions of Schooling and the Quality of Education (SACMEQ) testing of Gr 6 teachers on Gr 6 Mathematics content and the findings. The Quintile 1 teachers getting 28% for the content they are currently teaching and Quintile 5 teachers with a result of 54% for the classes they teach now, giving SA an average of 33%. The comparison with Kenya (82%), Botswana (52%) and Tanzania (53%) is alarming.

The TIMSS 1995 test results for teachers also revealed that Gr 8 Mathematics teachers in Singapore got 95%, Korea 87% and SA 16% revealing their competence on the content they teach (Spaull, 2014). It could be asked what has happened in SA the past 20 years since we have been ranked so low?

2.4. The influence of school Mathematics on university achievement

Given the situation in schools as explained above and scarcity of Science students in Higher Education everybody is fishing in the same pool of limited qualifying students. There is an international drive to recruit students to study Sciences, with Blankley and Arnold (2001) expressing concern that students have a preference to study Commerce and earn good salaries. The shortage of students refers directly to the shortage of qualified and dedicated Mathematics and Physical Science teachers (Jacobs, 2010). This study indicated that SA needs 22 000 new teachers to enter the profession per annum, currently not more than 5 500 graduates commence teaching every year.

Blankley and Arnold (2001) investigated the Science and Engineering student performance and found that first year students' marks had almost declined by 25% from their school results. Students in their first year of medical studies (highly selected students) demonstrated a 33% performance decline from school to first year university. In this study the students failed mainly the Physics modules and, although they were top achievers at school, they were unsuccessful with performing well in the university environment. In 2008, an analysis of Gr 12-results and university achievement was conducted at the University of Johannesburg (UJ) (UJ, 2008), showing a significant discrepancy between school and university achievement. At one university, only 17% of first year students passed the first Chemistry test in 2009 as reported by Rademeyer (Beeld, 09 April 2009), in comparison to 47% who passed a similar test in 2008. Another institution declared that in the mid-year examinations, only 35% of Engineering students passed in 2009, compared to 71% in previous years (Potgieter; Davidowitz & Venter, 2008). Many more students enrolled at institutions in 2009 and the larger classes created logistical problems and even higher failure rates.

3. ADMISSION IN HIGHER EDUCATION

The admission of students to university has been directed by admission requirements determined by HEIs in South Africa. Most applicants apply with Gr 11 school results – which might differ from the final Gr 12-results in many cases (Nel & Kistner, 2009). Institutions assume that by the end of Gr 10 students have made the correct programme selection and know what they wish to study. In the experience of the researcher, little career counselling takes place at schools, and only very dedicated students have any idea of what they wish to study. Even good students experience difficulty with the transition and change courses or modules after a while within their first year or thereafter.

Applicants apply and their Gr 12 results are accumulated to calculate an Admission Points Score (APS), applicable to the NSC before 2015 and now the CAPS in 2015 (Wits, 2013; UP, 2014, and UJ, 2014). A result of 80-100% would be converted to an APS-score of 7 and 40-49% would have a value of 3, as an example. Local university programmes require English, Mathematics and Physical Science results to range from a value of 4 to 6, for admission into Science programmes with an accumulative APS ranging from 20 to 45. Before the NSC was introduced a similar system of M-score was implemented as the total admission requirement.

3.1. Access and proficiency testing

A decade ago, institutions developed their own testing instruments such as the Alternative Admissions Research Project (AARP) at the University of Cape Town (UCT) in the late 1980s (Jacobs, 2010). Other tests in South Africa were the Tertiary Education Linkages Project (TELP); the Standarised Assessment Tests for Access and Placement (SATAP); the Science Foundation

Programme (SFP) and at University of Pretoria (UP,) Prof Potgieter developed a Chemistry test specifically to evaluate placement decisions (Potgieter; Davidowitz & Venter, 2008).

The University of Stellenbosch (US) had an Access Test developed from a diagnostic test battery (1998 to 2004) and then from 2005 the test served as an admission instrument which provided additional information concerning applicants. This test also measured skills and abilities and was contextualised for the multi-cultural, multi-lingual and multi-ethnic South African society. Nel and Kistner (2009) made a strong argument for the inclusion of an additional measuring instrument to be applied in collaboration with Grade 12-results (Botha; Du Plessis; Kistner & Nel, 2008).

3.2. National Benchmark Test (NBT)

Higher Education South Africa (HESA), has expressed concern about the shortage of students who can read, write and comprehend adequately. "Less than a half of first-year students have the academic literacy skills needed to succeed without support" (HESA, 2008). The sector is used to perform some testing, and HESA commissioned the National Benchmark Test (NBT) Project in 2005 to supplement the new school-leaving examinations. This test is available to every Grade 12-learner in South Africa at a very affordable price and was piloted in 2009 (Yeld, 2009a). The three core areas evaluated in the NBT are Academic Literacy, Quantitative Literacy and Mathematics (Table 3 in addendum).

Yeld (2009b) is positive that NBT-results in Mathematics and Academic Literacy will be valuable for Higher Education, from 2010 onwards. The evaluation scale was initially divided into three categories: Proficient, Intermediate and Basic achievement. The project team later divided the Intermediate scale to a "top" intermediate and a "bottom" intermediate to refine this category. In Table 4 (in the addendum) the norms and categories with implications of each are shown (NBTP, 2013). As mentioned the study by Wilson-Strydom (2012) provides useful application at the UFS. An investigation at UFS shows that only 2.4% of the students were proficient in the Mathematics subtest. The University found that the AL-subtest was an indicator of university performance but that the NBT Mathematics gave no such conclusive results.

At the University of Johannesburg the NBT results in 2014 (UJ, 2015) showed that only 6.9% of the main stream Science students were proficient in Mathematics, 55.4% were in the intermediate band and would have challenges and would need support and the 11.5% BSc degree students in the Basic band, would possibly reveal serious learning challenges. In 2015, the first cohort from the CAPS curriculum, entered the first year and the Science students performed as follows: only 6.13% of the main stream Science students were proficient in Mathematics, 59.9% were in the intermediate band and would need some support and 34.0 % of the BSc degree students in the Basic band, would possibly reveal serious learning challenges. (UJ, 2015). Results of the university performance of these students will be analysed after the end of 2015 and reported on in a next paper.

4. AN EMPIRICAL INVESTIGATION

4.1. Research methodology and purpose

The research paradigm refers to the worldviews of the researcher which guides the beliefs and perceptions underlying the approach to the research problem. The data collection instruments, selection of participants and methods of analyses, was steered by decisions from the research paradigm with a post-positivist worldview, (Heppner & Heppner, 2004), which presumes that an external reality exists independent from the researchers, and although this reality cannot be known fully, attempts at measuring it would be possible. This quantitative study dimension relates to an attempt to measure participants' pre-university performance and university performance after the first semester.

After an initial investigation with the results of the SU access test and M-score (Jacobs, 2010), this study compares the NSC-results (with an APS) and university performance by incorporating the NBT results. In a further quantitative investigation the focus is on identifying variables that may be used to predict student success in fundamental Science modules (Mathematics, Chemistry and Physics). The variables (Gr 12 results and NBT scores) can be quantified and measured and are applied to research predictive value of first year results. The data set contains school results, the NBT results (2012 – 2014) and results in the "gateway" first year modules mentioned above. These modules are modules that most Science and all Engineering students have to complete in the first year.

4.2. Empirical investigation

The data is applicable to three cohorts (2012-2014) of first year students in three Science modules at UJ in the BSc degree programme grouped into one sample. There were 1222 useable student profiles of first years in the three modules but many students did not complete the NBT. The cohorts that was used in the sample was 88 participants in 2012, 172 in 2013 and 246 in 214. The sample of 506 participants consisted of 73.2% Black students (indication that English is mostly a second language), and 84% (19 years or younger) with 16% (20 years and older).

4.3. Data collection and analysis

Data were collected via the university system where school results and NBT-results are captured and the faculty records after the June assessment in the three years (2012-2014).

The relationship between performance in the NBT Mathematics Test and in specific first-year modules was examined by means of hierarchical multiple regression analyses. In these analyses, the aim was to examine whether the NBT results have predictive value above and beyond performance in Grade 12. The descriptive statistical techniques were performed with SPSS (Pallant, 2007).

The order of entry of variables in the hierarchical analyses was as follows:

Step 1: Grade 12-performance (APS)

Step 2: NBT Mathematics test

At each step of the analysis, an R^2-statistic was computed and found to be between 0.138 and 0.242 for step 1 and between 0.102 and 0.158 for step 2. The R^2 showed the proportion of variance in the dependent variable that is explained by the independent variable(s) included at the step. The difference between the R^2 at Step 1 and the R^2 at Step 2 indicates the amount of variance uniquely explained by the NBT after taking into account the role of APS. A statistically significant ($p < 0.05$) change in R^2 from Step 1 to Step 2 signifies that the NBT have predictive value over and above the Grade 12-performance.

4.3. Reliability and validity measures

The Grade 12 results of entering students are validated by Umalusi (the Quality Assurance body of this examination). The NBT as well as university results are also validated by several mechanisms within the governance structures that ensures the sight and content validity.

4.4. Findings

The findings indicate the predictive value in respect of success in three first year Science modules at UJ in 2012-2014. The three cohorts were calculated as one group because the sample in 2012 was small (n=88) and increased to 2014 (n=246).

Table 5 (in the addendum) provides the proportions of variance explained by (a) the APS score, (b) the NBT Mathematics test conditional on the APS score, and (c) the APS score and NBT Mathematics test combined for the three different modules.

The results in Table 5 show that APS on its own accounted for 13.8% of the variance in Mathematics 1A, and that the NBT accounted for a further 12.4% of the variance, thus both contributed significantly towards the explanation of student achievement in Mathematics 1A and jointly accounted for 26.2% of the total variance in Mathematics 1A. Similarly, the APS and NBT accounted for 34.4% and 30.7% of the total variance in Chemistry 1A and Physics 1A respectively. The contribution of the APS is larger in Chemistry 1A but in all three cases the joint contribution to the total variance is above 25%.

Inspection of these results indicate that although the APS on its own account for 13.8% of the variance in Mathematics 1A, 24.2% in Chemistry 1A and 18.9% of the total variance in Physics 1A, the additional contribution from the NBT of 12.4% of the variance in Mathematics 1A, 10.2% in Chemistry 1A and 15.8% in Physics 1A, contribute statistically towards the explanation of the student achievement in these modules.

5. IN CONCLUSION

The literature indicates that with the increased number of learners that are passing Mathematics and Physical Science at school, universities need to find strategies to understand and deal with the declining pass rate at university level. The deductions from this study show that Grade 12 and NBT results could jointly provide information to academics to apply towards placement or diagnostic evaluation of incoming students. If more students are in the intermediate band they are going to experience difficulty in dealing with the demands of Science modules and it can be predicted that their academic progress will be affected. The fact that institutions know something about the students' readiness to enter university modules even before they register for any programme is important and should stimulate academics to find solutions. We could also place students in basic and lower intermediate extended programmes before they even start.

The multiple regression analysis yielded support for the predictive validity of the NBT Mathematics test. On average, the aggregate high school mark (APS) accounted for a significant variance in first year gateway Science modules (13.8% to 24.2%) but the NBT Mathematics test accounted for a significant amount of additional variance (10.2% -to- 15.8%) and should be taken into consideration. It is recommended that Faculties of Science and Engineering firstly acknowledge that the school results does not indicate probable academic success on its own. Secondly, universities have the NBT profile available and this could serve as diagnostic instrument to consider support and intervention programmes for all students entering with NBT Mathematics in the Intermediate and Basic bands. Furthermore, students entering in the Proficient category could be predicted to be top achieving students and placed in enrichment modules or programmes.

In assisting entering students more intervention and support programmes (CHE, 2013) can be suggested to improve pass rates:

i) Extend the curriculum with foundational provision to assist with language or other underdeveloped skills;
ii) Placing students in generic programmes for the first part of the year (quarter or semester) from where the institution (with sound knowledge of the ability) place students in degree (e.g. 3 year BSc); extended degree (e.g. 4 year BSc); diploma (e.g. 3 year Dip) or extended diploma (e.g. 4 year Dip) programmes;
iii) Placing students in tutor groups that are smaller sized, where students get more attention and motivation than in a larger class;
iv) Provide students with workshops in study skills, laboratory and computer proficiency so that they feel confident in the scientific environment;

v) Place students in mentor groups with selected senior students that can assist with content tutoring but also as guardians to act as role models and support decision making.

In the conversations around retention and high drop-out rates institutions should think about these issues as trained scientists. In our quest to find solutions and remedies for the most severe issues in the environment, health, industry and the financial world the academics in Sciences have always been very competitive with the international world. The author has no doubt that scientists can again lead the higher education sector in SA in finding solutions to offer students entering universities with enough options to cater for different needs, but we all need to consolidate our thoughts and provide sound alternatives.

6. REFERENCES

Blankley, W., & Arnold, R. (2001). Public understanding of science in South Africa: aiming for better intervention strategies. *Science Education South African Journal of Science* 97, 65-69.

Botha, L., Du Plessis, A., Kistner, L., & Nel, C. (2008). Toegangstoetse aan die Universiteit Stellenbosch en die Nuwe Nasionale Seniorsertifikaat. Ongepubliseerde Verslag. Stellenbosch Universiteit, Stellenbosch.

Brombacher, A. (2004). Mathematics options for Grade 12 – A critical perspective. Commissioned by the FET-HE Task Team of SAUVCA. (Paper presented at the DoE seminar held in Pretoria on 29 June.) Pretoria.

Bunting, I. A. (2008). Centre for Higher Education Transformation (CHET). 2004. *Transformation in higher education: Global pressures and local realities. 2nd revised edition*. Pretoria, CHET.

CHE (Council on Higher Education). (2013). *A proposal for undergraduate curriculum reform in South Africa: The case for a flexible curriculum structure.* Pretoria: CHE.

d'Hombres, B. (2007). *The Impact of university reforms on dropout rates and student status: Evidence from Italy*. JRC. Scientific and Technical Reports.

Heppner, P. P., & Heppner, M. J. (Eds). (2004). *Writing and publishing your thesis, dissertation and research. A guide for students in the helping professions.* Belmont, CA: Brooks/Cole-Thomson Learning.

HESA (Higher Education South Africa). (2008). The class of 2008: Ring in the new. Press release. 31 December.

Jacobs, M. (2010). Framework for the Placement of University Students in Science programmes Unpublished PhD. Thesis. University of the Free State, Bloemfontein.

Jacobs, M., de Bruin, G. P., Van Tonder, S. P., & Viljoen, M. (2015). Articulation in Science programmes: A placement strategy to enhance student success. *South African Journal of Higher Education* 29(1), p.60-78.

National Benchmarks Tests Project. (2013). *NBTP report of candidates who applied to the University of Johannesburg – 2013 intake*. UCT, Cape Town.

Nel, C., & Kistner, L. (2009). The National Senior Certificate: Implications for access to higher education. *South African Journal of Higher Education* 23(5), p.953-973.

Nelson, C., Nelson, J. S., & Malone, B. G. (2000). Admission Models for At-Risk Graduate Students in Different Academic Disciplines. Paper presented at the Midwestern Educational Research Association, Chicago, IL

Pallant, J. (Ed.). (2007). *SPSS survival manual*. 3rd ed. Berkshire: Open University Press.

Potgieter, M., Davidowitz, B., & Venter, E. (2008). Assessment of preparedness of first-year Chemistry students: development and application of an instrument for diagnostic and placement purposes. *African Journal of Research in SMT Education* 12 (special edition):1-18.

Rademeyer, A. (2009, April 9). Net 17% van eerstejaars slaag Chemie. *Beeld*, p.1.

Rankin, N., Schöer, V., Sebastiao, C., & Van Walbeck, C. (2012). Predictors of academic performance: National Senior Certificate versus National Benchmark Test. *South African Journal of Higher Education* 26 (3): 546-563.

RSA DoE (Republic of South Africa Department of Education). (2007). *Report on the 2007 Senior Certificate examination*. Pretoria: Department of Education.

RSA DoE (Republic of South Africa Minister of Education). (2008a). *Ministerial Statement on Higher education Funding: 2009/10*. September 2008.

RSA DoE (Republic of South Africa Department of Education). (2008b). *Abridged Report: 2008 National Senior Certificate examination results*. December 2008. Pretoria: Department of Education.

RSA DBE (Republic of South Africa Department of Basic Education). (2011). Curriculum and Assessment Policy Statement Grades 10-12. Mathematics. December 2011. Pretoria:Department of Basic Education

Scott, I., Yeld, N., & Hendry, J. (2007). A case for improving teaching and learning in South African higher education. *Higher Education Monitor* 6:1-86.

Spaull, N. (2014). Matric 2013 in retrospect: selected findings and discussion. Presentation at the UJ / Kagiso Trust Education Conversation, held in Johannesburg on 19 February 2014. University of Johannesburg.

Taylor, S. (2011). Uncovering indicators of effective school management in South Africa using the National School Effectiveness Study. Stellenbosch Economic Working Papers: 10/11. Department of Economics, University of Stellenbosch.

Thompson, L., & Kobrak, P. (1983). Predicting the success of students in an MPA program. Teaching Political Science, 10(4), 184-193.

TIMSS. (2012). Trends in International Mathematics and Science Study (TIMSS).

Available from: http://nces.ed.gov/timss/results07.asp

University of Pretoria. Available from: http://web.up.ac.za/sitefiles

University of Johannesburg. (2008). Faculty of Science: Enrolment report. (Unpublished document.) Johannesburg.

University of Johannesburg. (2014). Faculty of Science: Rules and Regulations (Unpublished document.) Johannesburg.

University of Johannesburg. (2015). Faculty of Science: Enrolment report (Unpublished document.) Johannesburg.

University of Witwatersrand. Available from: http://web.wits.ac.za/sitefiles

Wilson-Strydom, M. (2012). Using the NBTs to inform institutional understanding of under-preparedness: Implications for admissions criteria. *South African Journal of Higher Education* 26(1), p.136-151.

Volmink, J. (2010). What can we learn from the NSC results? (Presentation at IIE Forum held in Sandton on 21 February) Varsity College, Johannesburg.

Yeld, N. (2009a). National Benchmark Test Project. (Workshop presented at the University of Johannesburg on 13 June). University of Johannesburg, Johannesburg.

Yeld, N. (2009b). Changing issues, changing questions, changing approaches. (Paper presented at the Colloquium on the use of admission, placement and benchmark tests in South African universities held in Cape Town on 18 September). University of the Western Cape, Cape Town.

APPENDIX A

TABLE 1: AN ANALYSIS OF THE NSC GR 12 MATHEMATICS AND PHYSICAL SCIENCE RESULTS IN 2006 TO 2009
(Adapted from SAIRR, 2009; Volmink, 2010)

Subject	Year (level)	Wrote	Passed at 30%	Passed at 40%	Passed at 50%	Passed at 60%
Mathematics	2006 *(HG)*	318 000		25 000 (8%)		
	2007 *(HG)*	348 000		25 000 (7%)		
	2008*	298 821	136 503 (46%)	89 788 (25%)	63 038 (18%)	42 323 (11%)
	2009*	290 630	133 789 (46%)	85 491 (29%)	52 866 (16%)	31 786 (8%)
Physical Science	2006 *(HG)*	69 302		29 781 (43%)		
	2007 *(HG)*	71 172		28 122 (40%)		
	2008*	217 300	119 206 (55%)	61 480 (28%)	32 524 (11%)	16 620 (6%)
	2009*	220 957	81 507 (37%)	45 531 (21%)	22 329 (10%)	10 308 (5%)

* NSC results (no differentiation in levels)

TABLE 2: AN ANALYSIS OF THE NSC GR 12 MATHEMATICS AND PHYSICAL SCIENCE RESULTS IN 2010 TO 2013 (Adapted from DBE, 2013)

	2010	2011	2012	2013
Learners in Grade 12	1 076 527	987 680	1 039 762	1 094 189
Learners wrote Grade 12	537 543 (49.9%)	496 090 (50.2%)	511 152 (49.2%)	562 112 (52.0%)
Learners passed in Grade 12	364 513 (67.8%)	348 117 (70.2%)	377 829 (73.9%)	439 779 (78.2%)
Learners qualify for Bachelor (% of those that passed)	126 371 (23.5%)	120 767 (24.3%)	136 047 (26.6%)	171 755 (30.6%)
Learners passed Mathematics	124 749 (47.4%)	104 033 (46.3%)	121 970 (54.0%)	142 666 (59.1%)
Learners passed Physical Science	98 260 (47.8%)	96 441 (53.4%)	109 918 (61.3%)	124 206 (67.4%)

TABLE 3: THE COMPONENTS OF THE NBT
(Adapted from Yeld 2009b)

Test component	The purpose of the test is to determine	Duration of test
Academic literacy	Students' capacity to engage successfully with the demands of academic study in the medium of instruction.	One 3-hour test
Quantitative literacy	Students' ability to manage situations or solve problems of a quantitative nature in real contexts relevant to Higher Education	
Mathematics	Students' ability related to Mathematical concepts that form part of the NSC Mathematics curriculum.	One 3-hour test

TABLE 4: RATING AND INTERPRETATION OF THE NBT
(Adapted from Yeld, 2009 ; UJ, 2013)

Rating	Benchmarks	Indication of achievement	Implications for HE
Proficient	AL [100-64] QL [100-70] MATH [100-68]	Test performance suggests that future academic achievement will not be adversely affected and indicates that the student is competent and capable of passing	Place the student in a regular degree programme
Intermediate Upper	AL [63-51] QL [69-54] MATH [67-52]	The challenges identified are such that it is predicted that academic progress will be adversely affected. Students' academic needs should be met as deemed appropriate by the institution (augmented/extended/special provision).	Placing the student in a regular degree programme might be a risk. Students are likely to need complimentary support.
Intermediate Lower	AL [52-42] QL [53-38] MATH [51-35]		Students need to be placed in extended programme
Basic	AL [41-0] QL [37-0] MATH [34-0]	Test performance reveals serious learning challenges. Predictions are that the student will not cope with degree-level study without extensive support.	Place the student in a bridging or extended degree or diploma programme and provide additional support.

TABLE 5: PROPORTION OF VARIANCE IN FIRST YEAR MODULES EXPLAINED BY MATHEMATICS (NBT) AND APS (2012 – 2014 cohort)

Module	n	% Variance explained by the APS	*p*	% Additional variance explained by the NBT Mathematics Test	*p*	% Total variance explained
MAT 1A	506	13.8	0.869	10.9	0.763	23.8
CEM 1A	290	24.2	0.874	9.2	0.861	31.6
PHY 1A	247	18.9	0.481	13.6	0.622	28.5