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Exploring the association of the National Benchmark Test results with the academic performance of medical students who completed the degree in minimum time

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Abstract

The National Benchmark Tests (NBT) have been used for selection and placement of students in South Africa since 2005. The NBT assess students' cognitive knowledge in three domains: academic literacy; quantitative literacy; and mathematics. In this study we aimed to explore the NBT entry-level abilities in relation to school quintiles of the 2011 class of medical students at the University of the Witwatersrand who graduated in minimum time and to explore the link between the NBT domains and academic performance in the first, third, and sixth year of study. The results of students who attended Quintile 5 schools (n = 93) show that 31% obtained proficiency in NBT mathematics, 65% in NBT academic literacy, and 79% in NBT quantitative literacy. The academic literacy domain was a consistently significant predictor in all three years of study. The results show that proficiency and intermediate upper levels of all NBT domains are associated with minimum time completion.

Keywords: academic performance, NBT academic literacy, NBT mathematics, NBT quantitative literacy, NBT domains, medical students

Background

The National Benchmark Tests (NBT) were commissioned by Higher Education South Africa (HESA), now Universities South Africa (USAf), to evaluate the academic readiness of students entering university, as Marnewick (2012) has reminded us. The NBT are used in

combination with secondary school reports on learning achieved in content specific courses to assess the academic readiness of students as Yeld (2007) has pointed out. The NBT assess students' readiness in the three domains of NBT mathematics (NBTMA), NBT academic literacy (NBTAL) and NBT quantitative literacy (NBTQL). Van der Westhuizen and Barlow-Jones (2015) have reported that the three domains have a significant influence on students' academic performance, and the results are used not only to select students but also to determine the level of support they will require in their selected fields of study. The three domains are criterion-referenced tests; for le Roux and Sebolai (2016), they measure candidates' cognitive abilities in clearly defined domains that require comprehensive knowledge and their ability to apply it.

The NBTMA test is designed only for prospective university students who intend to study programmes that require mathematics, and it assesses the critical components covered in the school curriculum (Bohlmann, 2015). Prince's (2016) work on the NBTAL as a test of academic reading and reasoning ability that aims to examine students' ability to engage successfully with the language demands of higher education is pertinent here. The NBTQL focuses on the assessment of numeracy as described in adult literacy and life skills as well as on the broader definition of academic literacies as discussed in new literacies studies (Prince, 2016; Street & Baker, 2006).

The students' performance in these domains is placed on three benchmark performance levels: proficient; intermediate; and basic. For le Roux and Sebolai (2016) proficiency entails that a future student's academic performance will not be affected academically, while an intermediate benchmark performance level predicts that academic performance may be affected in certain domains. Prince (2016) has pointed out that students' results in the NBT domains are saturated in the intermediate band and this led to the need to split the intermediate band into Intermediate Upper (IU) and Intermediate Lower (IL). The IU performance suggests that these students will require supplementary support such as additional tutorials, workshops, courses, and language intensive work and IL indicates that the student will need placement in an extended programme of study (National Benchmark Test, 2016). The basic performance level signals serious learning challenges and implies that a student will not be able to cope with the demands of higher education. The NBT results also play a fundamental role in the admission and placement of students in appropriate curricular routes such as mainstream, augmented, or an extended programme (le Roux & Sebolai, 2016). See Table 1 and Table 2 below.

Table 1: National Benchmark Test degree performance

National Benchmark Test degree performance	
Proficient	AL = 64%–100% QL = 70%–100% MAT = 68%–100%

Intermediate	AL = 38%–63% QL = 38%–69% MAT = 35%–67%
Basic	AL = 0%–37% QL = 0%–37% MAT = 0%–34%

Table 2: NBT Intermediate performance bands

NBT intermediate bands	
Intermediate Upper	AL = 51%–63% QL = 54%–69% MAT = 52%–67%
Intermediate Lower	AL = 38%–50% QL = 38%–53% MAT = 35%–51%

The opportunity to enrol for a medical degree in one of the nine universities offering medicine in South Africa (and around the world) is relatively competitive because of limited spaces available in relation to the pool of applications (Bore, Munro, & Powis, 2009; van der Merwe et al., 2016). The selection tests, often referred to as rejection tests, are used widely to assess students' ability to cope with the demands of higher education in the programmes of their choice. South African history is plagued with economic inequalities and the consequent substandard schooling, especially in rural areas. These disparities influence school leaving grades, which may, on the one hand, adversely affect performance in the selection tests (Modisaotsile, 2012; Subotzky & Prinsloo, 2011). On the other, South Africa's history presents barriers to students from poor backgrounds and poorly resourced schools (Van der Merwe et al., 2016). Venkat and Spaull (2015) have pointed out that the South African school quintile classifications system states that Quintile 1 is comprised of the poorest schools (20% of the total), Quintile 2 of the next poorest (20% of the total) all the way up to Quintile 5 which is comprised of the wealthiest schools (again, 20% of the total) and that the distribution of teachers with strong content knowledge are concentrated in Quintile 5 schools. As a result, the school leaving results and selection tests may not reflect the true potential of the students who attended lower quintile schools (Ross, Loeffler, Schipper, Vandermeer, & Allan, 2013).

Few studies have been conducted to determine the link between admission criteria and academic performance in the medical programme. Allers, Hay, and van Rensburg (2016), found that English, life sciences, and NBT quantitative literacy were the best predictors of success in the first year of study of a physiology premedical subject. In a study to explore the predictive capacity of the NBT and Grade 12 mathematics results in the academic performance of first-year economics students, QL and AL were found to be the significant predictors of academic success (Rankin, Schoer, Sebastiao, & van Walbeek, 2012).

A variety of selection tests has been used to select and predict the academic performance of medical students. International selection tests such as the American College Test (ACT), Scholastic Aptitude Test (SAT), and Medical College Admission Test (MCAT) are used in the selection of students, and, as Sladek, Bond, Frost, and Prior (2016) have made clear, there is empirical evidence concerning their predictive capacities. In South Africa, five universities offering medicine use Grade 12 and the NBT results to select students for entry to the medical degree. At the University of the Witwatersrand, where this study was conducted, student admission for the medical degree is based on the Composite Index (CI) which is made up of the combination of the National Senior Certificate (NSC) and NBT (average of the three domain) results. Both the NSC and the NBT contribute 50% towards the CI. There is a paucity of research addressing the relationship between the NBT results and academic performance throughout the degree (van der Merwe et al., 2016).

As Wadee and Cliff (2016) have noted, the medical programme at the University of the Witwatersrand has a minimum duration of six years for school entrants. The first two years include the basic sciences, anatomy, and physiology. The third and fourth year are regarded as the pre-clinical years and are comprised of a problem-based curriculum (PBL), with nine integrated system organ blocks. The fifth and the sixth years are the clinical years during which students are allocated to the clinical clerkships in four academic hospitals.

In this study, we explored the link between the NBT and the academic performance of the 2011 class of medical students who completed their degree in the minimum time of six years. We analysed the NBT proficiency levels by school quintile and explored the relationship between NBT results and grade point average (GPA) of the first, third, and sixth years of study of the 2011 graduating class. The GPA is the average of all subjects for each year of study.

Methods

Our purpose was to explore the degree of variance explained by the NBT domains of students' academic performance. A multiple regression analysis was used to explore the link between students' NBT results and GPA. The frequency tables and custom tables were used to analyse categorical data in order to understand the profiles of students who completed in minimum time. The regression coefficients of the NBT domains were compared to assess the relative importance of each domain on the outcome variable following Polit and Beck (2004). The results of the three NBT domains were used as independent variables. The dependent variables were the GPA of the first, third, and sixth year of study. The assumptions of the regression were thoroughly tested before the interpretation of the results. The sample size was reduced (to $n = 119$ students) after two cases were removed because of missing data. Ethical clearance was obtained from the Human Research Ethics Committee (HREC, clearance certificate number: M170490). The study used data routinely collected by the university's Business Intelligence Services (BIS). The data for the selected cohort was tracked through their undergraduate studies at first year, and at years three and six. The data describes the progress of the class admitted in 2011 and includes the students' biographical details and

academic performance from the first to the last year of study. The MBBCh class of 2011 was comprised of 183 students in the first year of study of whom 121 completed in 2016 following the minimum six years of study. Of the 121, 44 were male and 77 were female.

Figure 1: 2011 cohort admissions

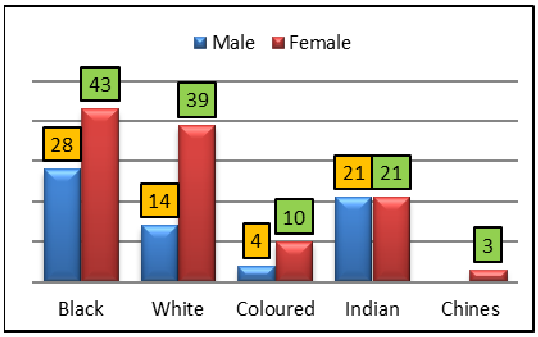
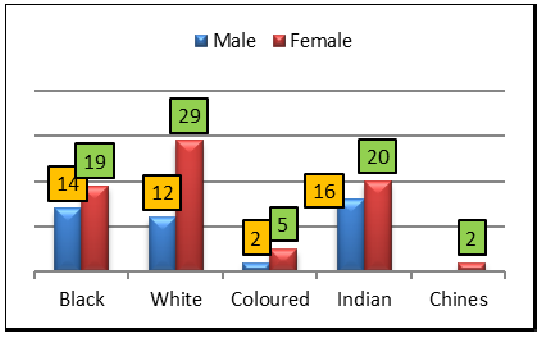


Figure 2: 2011-2016 cohort graduates



Results

Of this group of 118 students, 89% (n = 106) were South African citizens and 11% (n = 13) were international students. The students were from rural (5.9%) (n = 7) and urban areas 83.3% (n = 99). Regarding living arrangements, 67% of students of urban origin were living in private residential areas, and 16% were living in university residences. Only 2% of students of rural background were living in private residential areas, and 3% were living in university residences. Of the students of urban origin, 78% had attended Quintile 5 schools, and of 11% the quintile was unknown. The remaining 11% were students who attended Quintile 1 to 4 schools. The clustered bar charts above (See Figures 1 and 2) show the number of students admitted and those who completed the degree by race and gender.

Relationship of NBT domain to school quintile

The results show that of the 119 students who completed in minimum time, 78% (n = 93) attended the best-resourced (Quintile 5) schools, 13 did not indicate the quintile of the school attended, and the remaining 26 were spread across lower quintile schools. The NBT mathematics results of 93 students who attended Quintile 5 schools shows that 31% obtained Proficiency level, 32% obtained IU, and 14% obtained IL level. None of the students from lower resourced schools (Quintiles 1 and 2) achieved Proficiency levels in this domain. The results for the NBT academic literacy reveal that 80% obtained Proficiency level and 17% achieved IU level. Only two students who attended Quintile 2 schools obtained IL level on the NBT academic literacy. The results for the NBT quantitative literacy and school quintiles shows that 52% of students who attended Quintile 5 schools obtained Proficiency level, 25% achieved IU level and one obtained IL. Again, no student who attended a lower quintile school achieved Proficiency level in this domain.

Multiple regression results

First year of study

The NBT domains accounted for a statistically significant 35% of the variance in the academic success in the first years of study (R^2 =.35, F (3, 115) = 20.84, p = .000). The unstandardised (B) and standardised (β) regression coefficients together with squared semi-partial correlations for the unique contribution of each predictor in the multiple regression predicting the link between NBT and academic success in the first year of study are depicted below.

Table 3: First year unique contribution of each predictor variable (n = 119)

Variables	*B*[95% CI]	*β*	sr^2
NBT Mathematics	.135 [.039, .232]	.240	.006***
NBT Academic literacy	.261 [.089, .434]	.268	.003***
NBT Quantitative literacy	.162 [.035, .289]	.238	.013**

Note: N = 119. CI = Confidence Interval
*** p < .005. ** p < .01. * p < .05

As shown in the table above, the NBT domains were statistically significant predictors of academic success in the first year of study. The effect size of the regression model was large (f^2 = .56).

Third year of study

The NBT domains accounted for a statistically significant 24% of the variance in the academic success in the third year of study (R^2 =.24, F (3, 115) = 12.31, p = .000). The unstandardised (B) and standardised (β) regression coefficients together with squared semi-partial correlations for the unique contribution of each predictor in the Multiple Regression predicting the link between NBT and academic success in the third year of study are depicted below.

Table 4: Third year unique contribution of each predictor variable (n = 119)

Variables	*B* [95% CI]	*β*	sr^2
NBT Mathematics	.050 [-.027, .127]	.120	.199
NBT Academic literacy	.248 [.110, .386]	.343	.001***
NBT Quantitative literacy	.068 [-.034, .169]	.134	.189

Note: N = 119. CI = Confidence Interval
*** p < .005. ** p < .01. * p < .05

The NBTAL was the only statistically significant predictor of academic success in the third year of study. The effect size of the regression model was large (f^2 = .38).

Sixth year of study

In the first block, NBT domains accounted for a statistically significant 26% of the variance in the academic success in the first years of study (R^2 =.26, F (3, 115) = 14.03, p = .000). In the table below, unstandardised (B) and standardised (β) regression coefficients squared semi-partial correlations for the unique contribution of each predictor in the multiple regression predicting the link between NBT and academic success in the sixth year of study are depicted below.

Table 5: Sixth year unique contribution of each predictor variable (n = 119)

Variables	B[95% CI]	Beta	sr^2
NBT Mathematics	.026[-.26, .079]	.090	.325
NBT Academic literacy	.173 [.079, .267]	.346	.000***
NBT Quantitative literacy	.065[-.004, .134]	.186	.065

Note: N = 119. CI = Confidence Interval
*** p < .005. ** p < .01. * p < .05

The NBTAL scores continued to be a strong predictor linked with students' throughput in the sixth year of study. The effect size of the regression model was large (f^2 = .45).

Discussion

This study found that 78% (n = 93) of students attended Quintile 5 schools and of these 65% (n = 78) achieved Proficiency level in the NBT academic literacy, a domain that was statistically significant in predicting academic success in three years of study. Academic performance of this sample reflects a pattern of privilege as a marker of academic success since most of the successful students attended schools with better resources.

The NBT has been used as an additional test to select students for places in the medical programme. Van der Merwe et al. (2016) have expressed concerns about the capacity of the NBT to predict students' academic success. While all three NBT domains appear to have an impact on first year performance, only academic literacy retains its influence through to the final year of study. This may be because this domain tests students' reading and reasoning capacity to engage successfully with the language demands of higher education and this played a crucial role in their completion of the medical degree in minimum time. Furthermore, given that English is the medium of instruction throughout the programme, the results demonstrate that students' (English) literacy in the NBLAL allowed them to engage successfully with all learning required. Although we did not request the students' results in all the subscales of the NBTAL, the fact that 80% obtained Proficiency level suggests, in

keeping with the findings of Cliff and Hanslo (2010), that they possessed essential cognitive abilities in these subscales and that this had a fundamental influence on their academic success.

Again, most students were equally prepared to cope with the quantitative demands of medical education since 65% achieved Proficiency in NBTQL. For the NBT mathematics, 44% and 18% obtained IU and IL levels respectively. The students' performance in the NBT mathematics suggests that they needed additional support in order to cope with the demands of higher education.

However, NBTQL and the NBTMA were significant only in the first year of study. The possible explanation of this could be that subjects that require mathematics and quantitative knowledge are studied in the first two years of a medical school education. The clinical years of study in medicine are characterised by large volumes of content that require greater degrees of clinical reasoning. This may be the reason why academic literacy was a statistically significant predictor.

In this study, 78% of students who completed with unimpeded academic progress attended Quintile 5 schools. The schools categorised as Quintile 5 are well resourced, linked to better matric pass rates, and they cater less to poor learners as Venkat and Spaull (2015) found. The Quintile 5 schools are known to offer education that better equips students with essential academic capabilities to cope with higher education's academic demands. Simmenroth-Nayda and Görlich (2015) reported that social background influences students' performance in selection tests for medicine. These students are also more likely to perform better if their parents have an academic background. In the South African context, social and economic inequalities and substandard schooling, especially in lower quintile schools, not only compromise students' matric results but continue to have a negative impact on performance in selection tests and on academic performance (Modisaotsile, 2012; Ross et al., 2013). In this study, the fact that most students were of urban origin and had attended schools that are more affluent suggests that their family income may have contributed to their completing their studies in the minimum time.

In the global context there is little ongoing research linking performance in selection tests to academic performance in studying towards a medical degree. In China, the National College Entry Examination (NCEE), which is used to select students, was found to have a consistent predictive strength in the first year GPA of medical students (Zhou et al., 2014). Furthermore, McManus, Dewberry, Nicholson, and Dowell (2013) found that the United Kingdom Clinical Aptitude Test (UKCAT) has the potential to predict first-year performance in twelve medical schools when other influencing variables are considered. In this study, the full battery of the NBT range has predictive value in the first year of study but beyond this only the NBTAL domain maintains its predictive strength.

While students adapt to university life, performance in these tests combined with mediating variables like family support, being first-generation students, financial assistance or the lack of it, living in or out of university residence, proximity to the campus, the quintile of school

attended, and other variables continue to influence future academic performance. This broader consideration may have implications for university selection processes and the management of students by educators. In this study, only 13 students had attended Quintile 1 to 4 schools and five were of rural origin. While these students completed with unimpeded academic progress, other students admitted with similar entry level skills were found to need support on commencement of their studies (le Roux & Sebolai, 2016). Since these 13 students progressed and completed their studies in minimum time, it is important to understand what enabled them to navigate their studies given that they were admitted with relatively low entry-level skills.

Limitations and implications for future studies

The sample was a single cohort of medical students from one South African university, so it is important to guard against generalisation of the results without considering the context and methods. Academic and socioeconomic profiles of families are a marker of student success as we know from the work done by Steven, Dowell, Jackson, and Guthrie (2016). There are many factors that affect students' academic performance in South African universities. In this study we were not able to explore these factors and their impact on student success. Notwithstanding these limitations, the results of this study offer insights into the profile of students and the importance of entry-level skills to minimum time throughput.

Conclusion

This study confirms the predictive significance for academic performance in a medical degree of the NBTAL that assesses students' ability to engage successfully with the academic literacy demands of higher education. Furthermore, the results suggest that a vertical application of knowledge is tested in the NBTAL. The students admitted with low entry-level skills in the NBTAL must receive additional support to augment their abilities to engage better with the cognitive load.

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