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Impact of Mathematics and Physical Science on the Success of South African Engineering Technology Students*

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The general conclusion arrived at in the literature is that the South African National Senior Certificate (NSC) is not a reliable predictor of academic success at traditional universities. By sharing research undertaken at a South African University of Technology (UoT) on the impact of individual cognitive factors and NSC results on study success, this paper shows that this conclusion is not necessarily true for South African UoT Engineering students. To assess this impact and determine the readiness of students for UoT Engineering curricula, the relationship between pre-university academic factors and the success of engineering students was investigated. An ex post facto study was carried out on a sample of 416 students drawn from first-time-entering National Diploma engineering student cohorts of 2009 and 2010 to determine a possible correlation between their NSC results, additional pre-admission test results and the number of subjects passed after one year and four years of study, respectively. The findings indicated that NSC Mathematics and Physical Science are statistically the most significant predictors of success in the first year. Despite the pre-admission tests used in this study not revealing significantly more about a student's potential than only the final NSC results, the conclusion reached by the researchers was that such tests might be useful when student application data is unreliable, i.e. when students apply with Grade 11 or interim Grade 12 results.

Keywords: National Senior Certificate; engineering curricula; cognitive factors; first-year success; admission testing; student dropout

1. Introduction

Various studies have shown that the higher education study duration and success rate vary considerably between countries. While higher education participation rates have risen sharply in many European countries, about one third of all entrants leave higher education without completing a degree. Completion rates vary greatly between countries: in some countries, only a minority of entrants complete the course; in others, almost all do. Higher education survival rates range from over 80% in the United Kingdom to 55% or less in Austria, France, Portugal and Turkey; in Italy the survival rate is just 35% [1]. Overall, a third of students in the Organisation for Economic Co-operation and Development (OECD) countries withdraw from higher education before obtaining a diploma [2]. Success rates also vary considerably between different fields of study. The highest success rates are frequently found in medicine and dentistry courses, while the technology educational sector often falls behind, achieving only moderate or low success rates.

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The Higher Education Management Information System (HEMIS) of the South African Department of Higher Education and Training (DHET) only recently matured to such an extent that broad undergraduate cohort studies, starting with the 2000 first time entering intake, became possible. Scott, Yeld and Henry [3], in a research report commissioned by the Council for Higher Education (CHE) of South Africa, reported that despite significant improvements in access, substantial shortcomings in performance in terms of completion rates remain. These researchers performed a basic analysis of current student performance patterns using a disaggregation of student data provided by the DHET and argued that systemic responses, such as the reform of core curriculum frameworks, building educational expertise in the sector and strengthening structures to enforce accountability, are essential for improving outcomes.

In their report, Scott, Yeld and Henry [3] noted how the 2000 cohort study conducted by the DHET revealed that, five years after entering their course of study (i.e. in 2004), only 30% of the total first-time-entering student intake had graduated, 14% were still in the system and 56% had left without graduat-

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ing. Only 54% of the students who enrolled for a four-year professional bachelor's degree in 2000 in Engineering, had graduated within a five-year period, while 19% were still in the system. Although disturbing overall, the picture for engineering students at Universities of Technology (UoTs) is much worse. Nationally, a mere 17% of students who enrolled for a three year National Diploma in Engineering in 2000, at residential educational institutions graduated within a five-year period while 14% were still in the system. Based on these findings, fundamental, targeted interventions are clearly long overdue and urgently required.

Despite the survival rate of tertiary students being comparable to that of some European countries, the dismal state of the secondary and primary school system in South Africa is no secret. Higher Education South Africa (HESA) chairman, Professor Theuns Eloff, during August 2009, told Parliament's higher education committee that most first-year students could not read, write or comprehend adequately [4]. Professor Nan Yeld, Dean of the Centre for Higher Education Development at the University of Cape Town, is the principal investigator of the National Benchmark Tests Project (NBTP), commissioned in 2005 by HESA. The NBTP, initiated to provide criterion-referenced information to supplement the new national school-leaving examinations and based on a new school curriculum, had its first trials in February 2009 and the outcome has not been encouraging [5]. Thirteen thousand students already accepted for tertiary education were tested. Findings revealed that only 25% were proficient in quantitative literacy. Only 7% tested proficient in mathematics and a meagre 20% tested achieved an intermediate level in mathematics. No more than 47% tested were proficient in English, the dominant language used for tertiary education [5]. With fewer than half of all first-year students possessing the necessary academic skills to succeed, vice-chancellors warned Parliament that a further drop in retention of, in particular, black students, who comprise approximately 63% of the total enrolment, should be expected [4]. The majority of the students tested were first graduates of the Outcomes Based Education (OBE) school curriculum, which is widely blamed for the prevailing situation. Although findings such as those reported by Rudd and Steedman [6] showing that in the UK middle range General Certificate of Secondary Education (GCSE) grades (C, D, E and F) in English and Mathematics do not appear to guarantee threshold attainment levels in basic numeracy and literacy as measured by the Adult Literacy and Basic Skills Unit (ALBSU) tests, are alarming, the South African situation seems worst.

Internationally, many studies were done to compare the Scholastic Aptitude Test (SAT), Scholastic Assessment Test (SAT 1) and High School Grade Point Average (HSGPA), or indicators such as the General Certificate of Education Advanced Level (A-level) or the National Certificate for Educational Achievement (NCEA), with first year or freshman success [7–17]. Ting looked at non-cognitive factors, using the Non-Cognitive Questionnaire (NCQ) in combination with SAT and Grade Point Average (GPA) and found that the inclusion of non-cognitive factors with SAT is more effective in predicting success [18]. Studies such as the one by Sackett, Kuncel, Arneson, Cooper and Waters [14], where they mentioned that critics claim that SAT tests actually measure Socioeconomic Status (SES) [8], have added relevance in the South African context. In South Africa poverty is often divided along racial lines and a vast majority of students come from poor and historically disadvantaged communities [19–21] due to the Apartheid regime that did not afford everybody equal education. In South Africa SES plays a definite role in academic progress. According to Harding, the educational reform that was introduced by the new democratic government failed the poor again as the teachers did not manage to teach the Outcomes-based Education system that was adopted [20, 21].

2. Economic perspective

Underprepared students lead to extensive rates of dropping out, which in turn leads to economic loss and a shortage of high-level skills nationally. Scott, Yeld and Henry [3] re-iterated the findings of Moleke [22] who pointed out that the fact that high-level skills shortages have been identified is a clear indicator that the country's needs are not being met and that a mismatch between output and the requirements of the economy exists. Du Toit and Roodt [23], who conducted a detailed analysis to quantify the shortage of engineering skills in South Africa and put forward an array of reasons to explain the deficit, indicated that the shortage in engineering capacity faced by South Africa, particularly in the public sector, is one of the worst capacity and scarce-skills crises in a long time. They noted that South Africa only has 473 engineers per million citizens while Japan has 3 306 engineers per million citizens. Lawless [24] noted that South Africa's capacity is low when compared to other developing countries. To put it in another way, South Africa has 3 166 people per engineer while Malaysia has 543 people, Brazil 227 and India 157 people per engineer.

The theory of human capital [25–27] forms the starting point for an economic perspective on education. The length of the study duration in university education is interpreted as the result of individual cost-benefit considerations. Costs and benefits are understood in the broadest possible sense so that not just financial but also non-material arguments, e.g., 'usefulness and satisfaction', are considered [28]. Although cost-benefit considerations are an individual's decision, the decision is not reached on a purely individual basis. More factors than just his or her individual characteristics such as their capacities influence the size and capacity of the individual's costs and benefits; the student's social and cultural contexts also play a role [29, 30]. For example, the education and professions of the student's parents, as well as the parental income are strongly associated with this, and are co-determinants for the form and size of the cost-benefit curves [31]. A distinction is made in the so-called cultural theories, between the theoretical conflict vision, in which an individual's social status, race and gender determine his/her social position, and the structurally fundamental vision [32]. In this second vision, not only do social status, race and gender play a role but also individual (psychological) characteristics, such as aptitude, motivation and effort. Social skills acquired by the individual are influenced by (school) experiences, [33, 34]. In the present study, the focus is placed on the impact of individual cognitive factors on study success.

3. Research questions

The following research questions were formulated to determine the impact of individual cognitive factors, including that of the NSC, a national examination at the end of Grade 12, on study success when following a typical UoT Engineering curriculum:

1. What is the strength of the relationship between pre-admission cognitive factors (NSC, EPT, PIBspEEx and ELSA (section on Independent Variables refers)) and the number of subjects passed after *one* year of study?
2. What is the strength of the relationship between pre-admission cognitive factors (NSC, EPT, PIBspEEx and ELSA (section on Independent Variables refers)) and the number of subjects passed after *four* years of study?
3. Do additional tests such as the EPT, PIBspEEx and ELSA add any value to student selection?

4. Method

4.1 Setting and participants

This study was conducted in the Faculty of Engineering and the Built Environment of the Tshwane University of Technology (TUT), South Africa. Participants selected for this study were 174 first year students from the 2009 first-time-entering National Diploma cohort and 269 first year students from the 2010 first-time-entering National Diploma cohort. The data of 416 students were therefore available for the analysis of academic performance. The students in the sample were admitted based only on their NSC results, but were also subjected to the EPT, PIBspEEx and ELSA tests (the following section refers) during the faculty's Orientation Week, to collect cognitive factor data and to establish which students might need additional support. International students and other students who had not followed the NSC curriculum, students who wrote the NSC before 2008 (old curriculum) and students who had not attended the faculty orientation weeks during 2009 and 2010, were not included in the sample.

Currently, students interested in studying engineering at a South African University of Technology first enrol for a three year National Diploma. After successfully completing the National Diploma, deserving students may add another year of full-time study to obtain the Bachelor of Technology degree. The Engineering Council of South Africa (ECSA), a co-signatory of the Dublin and Sydney accords, accredits these qualifications, resulting in international recognition in co-signatory countries. The National Diploma comprises *four semesters* of theoretical study and *two semesters* of industry placement. Providing that a student does not fail any subject, he/she will be able, on average (depending on the engineering sub-discipline) to complete 12 of the 24 theoretical subjects during the first year. Since there is on average, a lag of *three months* to find industry placement, students in the sample were tracked for *four* years, i.e. one year longer than the minimum duration of *three* years to obtain the National Diploma.

During the first year, only 18% of students in the sample passed *all* their subjects. After four years, 28% of students in the sample met the requirements for graduation, a significantly higher percentage than that of the National Diploma in Engineering's average for the 2000 cohort as reported by Scott, Yeld and Henry [15]. Eighteen percent of the sample dropped out or were academically excluded, leaving 54% remaining in the system. About 28% of the students in the sample who remained in the system after the *fourth* year were busy completing their industry placement requirement. Students at TUT are usually allowed double the minimum duration, i.e. *six* years, to complete the National Diploma.

4.2 Independent variables

4.2.1 National senior certificate

The Mathematics, Physical Science and English scores, as well as the Academic Potential Score (APS), i.e. the aggregate of all NSC subjects, excluding Life Orientation, were used.

4.2.2 PIBSpEEx [34]

The PIBSpEEx is a commercial test developed by Psi systems and has been used by TUT (previously Technikon Pretoria, before 2004) for more than a decade. In this study, only the seven PIBSpEEx source competencies related to cognitive potential were used. The PIBSpEEx scales are classified by the Psychometrics Committee of the Board for Psychology of the Health Professions Council of South Africa (HPCSA) and are subjected to ongoing independent research. Claimed predictive validities range from 0.70 to 0.94 while test reliabilities range from 0.58 to 0.92.

4.2.3 Engineering Placement Test

The EPT was developed at TUT (Technikon Pretoria prior to January 2004) as part of an Engineering Access Initiative and has been used as part of a battery of admission tests during the period 1999–2007. Each question, sub-section, student scores and subsequent student performance during the first year of study, were reviewed on an annual basis to find a balance between predictive validities and test reliability. In contrast to the PIBSpEEx source competencies, which focus on cognitive potential, the EPT largely tests for a basic discipline-specific understanding and the ability to apply basic mathematics and science knowledge to solve problems. Further development on the EPT ceased in 2007.

4.2.4 ELSA [36]

The English Literacy Skills Assessment test is a standardised English proficiency measuring instrument designed and developed in South Africa by the Hough and Horne consultancy. Reported predictive validity is 84% and reported reliability is 0.67.

4.3 Dependent variables

The respective percentages of subjects passed, after the first and fourth years of study, were used as dependent variables. The students who do not succeed in passing more than 50% of the prescribed subjects for a particular year of study at TUT are placed on academic probation. For the purpose of our study, we did not exclude students from our sample that withdrew or were academically excluded before the end of the period under investigation, since the ultimate aim of this study was to identify which independent variables are able to predict success reliably.

5. Limitations

Before data from this study is analysed, discussed and conclusions drawn, some limitations should be noted:

1. Although the NSC is a National examination and TUT currently is one the most demographically representative UoTs in South Africa, the data has nonetheless been drawn from a single institution and caution should be exercised before broad generalisations are made.
2. As mentioned, the EPT is unique to TUT and not all UoTs administer the PIBSpEEx or ELSA tests. Caution should therefore be exercised before generalising the value of additional admission tests.
3. Although all National Diplomas in Engineering at South African universities are quality assured by ECSA and follow the contents described in Nated Report 151 [37], small institutional differences are inevitable.

6. Data analysis

In summary, the study attempted to identify which independent variable(s) (NSC, PIBspEEx, EPT and ELSA) might serve as predictors for academic success as measured by the dependent variables (percentage of subjects passed after the first and fourth years of study).

MATLAB, Version 7, was utilised for all analyses conducted. Firstly, significance tests determined which independent variables were significantly different for the group of students who passed more than 50% of the curriculum during a given period, and the group whose members failed more than 50%. Both the two-sided *t-test* and bi-variate logistic regression were used. Where appropriate, the Wilcoxon rank sum test was also performed to verify the results of the two-sided *t-test* since there were concerns that not all independent variables were normally distributed. Pearson correlation was carried out to determine if there was a significant correlation between an independent variable and the percentage of subjects passed during a specific period. Stepwise linear regression, a step-by-step, iterative construction of a linear regression model to find the combination of independent variables that best explain the dependant variable, was also performed. To enable us to compare the magnitude of the regression coefficients, the independent variables were normalised by subtracting the mean and dividing by the variance.

6.1 *After one year*

The correlation between the significance values given by the two-sided *t-test* and bi-variate logistic regression, which was included for confirmation and comparison purposes, is obvious in Table 1. It is clear that of all NSC results, Mathematics and Physical Science are the two most significant independent variables to discriminate between the group who passed $\geq$ 50% of their subjects and the group who failed >50% . Pearson correlation was also performed to determine if there was a significant correlation between an independent variable and the percentage of subjects passed after one year. The correlation coefficients are indicated in parentheses; it is obvious that of all NSC results, Mathematics has the highest correlation coefficient, i.e. 0.32.

Stepwise linear regression was also performed. To enable the researchers to compare the magnitude of the regression coefficients, given in parentheses, the independent variables were normalised by subtracting the mean and dividing by the variance. The coefficient for Mathematics is only marginally larger than the coefficient for Physical Science while both their significance values are smaller than 0.001. The standard errors are indicated in italics. None of the other NSC, EPT or PIBspEEx variables, except Observance, from the PIBspEEx test, were included in the final result of the stepwise linear regression, irrespective of the initial variables used. The fraction of variability in the response fitted by the model (or explained variance) is 43%. If just Mathematics and Physical science are used, the fraction of variability in the response fitted by the model drops to 40%.

If one assumes that the final NSC results are not available, then the question arises whether the PIBspEEx and EPT results on their own have the same significance and predictive value as the NSC results. The results for such a scenario are provided in Table 2. Stepwise linear regression was again performed, but with the NSC results excluded. The independent variables were again normalised by subtracting the mean and dividing by the variance to enable us to compare the magnitudes of the coefficients. In the absence of NSC Mathematics, the Algebra section in the EPT gained prominence. The third column of Table 2 demonstrates that the magnitude of the coefficient for Algebra is more than twice the value of the coefficient for Observance. The fourth column of Table 2 demonstrates that when using different initial terms, *Algebra* and *Conceptualization* may alternatively end up in the final model. However, when both terms are made part of the model, their significance values decrease considerably; this is probably due to there being a significant correlation between these terms (correlation coefficient is 0.38). The fraction of variability in the response fitted by the model in column three is

Table 1. Significance values for NSC and pre-admission test variables (* < 0.1, ** < 0.05, *** < 0.01, **** < 0.001)

		Significance (*p*-value)			
Independent variables		**Two sided t-test/ Wilcoxon rank sum**	**Pearson Correlation**	**Bi-variate Logistic Regression**	**Stepwise Linear Regression**
PIBspEEx Test	1: Conceptualization	**	*** (0.19)	**	
	2: Mental Alertness	**	* * (0.13)	**	
	3: Observance	*	*** (0.18)	*	*** (4.57) *1.65*
	4: Insight	*	* (0.12)	*	
	5: Calculations		(0.01)		
	6: Assembly	*	* (0.12)	*	
	7: Reading Comprehension		(0.03)		
	8: Combined Score (Aggregate of 1–8)	**	*** (0.17)	**	
Engineering Placement Test	9: Algebra	****	*** (0.18)	** *	
	10: Logic	*	** (0.14)	*	
	11: Numeracy	***	*** (0.18)	** *	
	12: Mechanics		(0.02)		
	13: Electricity		(0.09)		
	14: Chemistry	**	** (0.13)	**	
	15: Trigonometry	**	** (0.14)	**	
	16: Combined Score (Aggregate of 9–15)	****	**** (0.22)	***	
NSC Results	15: Mathematics	****	**** (0.32)	****	**** (7.77) *1.66*
	16: Physical Science	****	**** (0.11)	****	*** (6.49) *1.72*
	17: English		(0.01)		
	18: APS (aggregate of NSC subjects)	***	*** (0.17)	**	
ELSA	*	(0.01)	*		

Table 2. Stepwise linear regression results for pre-admission test variables (*< 0.1, ** < 0.05, *** < 0.01, **** < 0.001).

PIBspEEx Test	1: Conceptualization		*** (5.47) *2.63*	* (3.74) *2.27*
	3: Observance	*** (4.8) *2.76*		* (1.9) *3.51*
Engineering Placement Test	9: Algebra	*** (10.4) *2.7*	** (9.37) *2.40*	** (9.64) *3.88*

Table 3. Significance of significant pre- and post-admission variables (* < 0.1, ** < 0.05, *** < 0.01, **** < 0.001)

Independent variables		Significance (*p*-value)		
		Two sided t-test/ Wilcoxon rank sum	**Pearson Correlation**	**Bi-variate Logistic Regression**
NSC Results	Mathematics	****	**** (0.23)	****
	Physical Science	**	** (0.12)	*
	English	**	** (0.12)	*
	APS (aggregate of NSC subjects)	***	** (0.13)	***
Post admission variables	Mathematics I	****	**** (0.55)	****
	% Subjects passed after *one semester*	****	**** (0.64)	****
	% Subjects passed after *one year*	****	**** (0.72)	****

25% while the variability in the response fitted by the model if *only* the combined EPT score is used, is 22%.

6.2 *After four years*

The correlation between the significance values given by the two-sided *t-test* and bi-variate logistic regression, which was included for confirmation and comparison purposes, is again apparent in Table 3. It is evident that of all the NSC results, Mathematics and APS are the two most significant independent variables to discriminate between the group who passed $\geq$ 50% of their subjects and the group who failed >50%. Pearson correlation was also performed to determine if there was a significant correlation between an independent variable and the percentage of subjects passed after four years. The correlation coefficients are indicated in brackets; it is clear that of all NSC results, Mathematics has the highest correlation coefficient, i.e. 0.23. The results for the PIBspEEx, EPT and ELSA tests are omitted, since the significance values for the two-sided *t-test,* bi-variate logistic regression and correlation were all > 0.1. It is also of interest that the significance value of Physical Science dropped to < 0.05, that the significance value of APS increased to < 0.01 and that a slight increase in the significance of English was observed. An explanation for this might be that the syllabus places a lesser emphasis on fundamentals and a greater emphasis on application, integration and communication, including presentations and report writing. Nevertheless, as expected, the performances of a student, after one semester and one year of study, have significance values < 0.001.

Pearson correlation was also performed to determine if there was a significant correlation between the NSC results, the percentage of subjects passed after one semester, and the percentage of subjects passed after one year together with the percentage subjects passed after four years. The correlation coefficients are shown in parentheses and it is obvious, that as expected, the percentage of subjects passed after one year of study is a powerful predictor of academic success during subsequent years.

7. Discussion

On average, as noted, the National Diploma students are required to complete 12 subjects during their first year. Of the students in the sample, only 18% passed all their first and second semester subjects during the first year. If one takes into consideration that at least nine of the subjects studied during the first year are mathematical and scientific in nature and use mathematical concepts extensively, then it comes as no surprise that there is such a strong correlation (0.32) between the performance in NSC Mathematics and the percentage of subjects passed during the first year. It is therefore logical that NSC Mathematics has a statistical significance value of less than 0.001 (two-sided *t-test*, bi-variate logistic regression and linear regression, as per Table 1), despite the criticisms levelled at the OBE syllabus and the South African schooling system in general. Klopper [38] and Rademeyer [20] pointed out that in 2008, when the first of these NSC exams were written, 592 000 of the learners wrote the mathematics exam in 2008, yet only 4% passed with more than 50%. As pointed out at the beginning of this article, the general conclusion drawn in the relevant literature is that the NSC is not a reliable predictor of academic success [39, 40]. The results in this paper have demonstrated that this conclusion is not necessarily true for UoT engineering students and that NSC Mathematics and Phy-

Table 4a. Cumulative Mathematics Profile of Sample

NSC Mathematics Score	Cumulative% Applicants
< 50%	7%
< 60%	26%
< 70%	59%
< 80%	89%
< 100%	100%

Table 4b. Cumulative Physical Science Profile of Sample

NSC Physical Science Score	Cumulative% Applicants
< 50%	18%
< 60%	50%
< 70%	83%
< 80%	96%
< 100%	100%

sical Science are indeed statistically significant indicators of success in engineering courses at a UoT. The problem is not with the NSC, but rather, as indicated in Tables 4a and 4b, that there are too few students with high enough NSC Mathematics and Physical Science results entering engineering programmes. When, for example, separating the sample into those who have passed with more than 50% of the subjects *after one year* and those who have not, the medians of the NSC Mathematics scores for these two groups are 5 (i.e. 60-69%) and 6 (i.e. 70-79%) respectively. Similarly the medians of the NSC Physical Science scores for these two groups are 4 (i.e. 50-59%) and 5 (i.e. 60-69%) respectively. The two-sided *t-test* confirmed that these differences are highly significant ($p < 0.0001$). As indicated in Tables 4a and 4b, the difficulty is that 33% (68%) of the sample obtained a score below 60% for Mathematics (Physical Science) and it is largely this group of students who were put on academic probation.

Table 3 showed that of all the NSC results, Mathematics and APS are the two most significant independent variables to discriminate between the group who passed $\geq$ 50% of their subjects and the group who failed >50% after *four* years of study. It is clear that of all NSC results, Mathematics has the highest correlation coefficient, i.e. 0.23. It is also obvious that, that as expected, the percentage of subjects passed after *one* year of study is a powerful predictor of academic success during subsequent years. Although Adamson and Clifford [16] in their UK-based study reported a much stronger correlation between A-levels and success than we reported between APS and success in the UoT system, equally high correlations between performances during the first and subsequent years, are reported. Nevertheless, directly comparing our results with similar studies conducted in other countries remain problematic due to differences between systems. Many comparable US-based studies use the HSGPA (comparable to the APS in the South African system) and SATMath scores, but not individual high school Mathematics and Physical Science scores, as independent variables. Although a weak relationship is sometimes reported between SAT scores and college performance (see [7] and [9] for example), if the APS and NSC Mathematics (or Algebra component of the EPT) scores are considered comparable to the HSGPA and the SATMath scores, our results are consistent with previous institutional and cross-institutional engineering education research studies showing that HSGPA and SATMath are reliable predictors of college level performance in engineering studies [11, 12].

Camara and Echternacht [7] mention the fact that colleges are selecting students but students are also selecting colleges. In this regard UoTs in South Africa are competing for the pool of students who did not get admission to traditional universities or who obtained lower Academic Potential Score (APS) scores from the onset. In general there are too few students with high enough NSC Mathematics and Physical Science results entering UoT engineering programmes and it is clear that similarly to other countries, South Africa is also experiencing a serious decline, not only in students' mastery of basic mathematical skills and level of preparation for mathematics-based degree courses, but also in the number taking preparatory mathematics courses, contributing to a smaller pool to select from [41, 42].

Another issue experienced by South African institutions is the fact that the majority of students apply using their Grade 11 or mid-Grade 12 results and that there is not a reliable correlation between these results and the final National NSC results. When correlating the results with which students applied and their final NSC results, then the correlation coefficients for Mathematics, Physical Science and English are 0.09, 0.20 and 0.33, respectively. It is thus straightforward to predict how this may lead to difficulties with selection, admission and planning. The only way to mitigate this problem is to use admission tests, since the results from tests such as the PIBspEEx and EPT correlate more accurately with performance during the first year (Tables 1 and 2 refer) than interim Grade 12 or Grade 11 results. Although the additional tests used in this study told us nothing more than could be inferred from the final NSC results, they do however have a purpose and place in the system, until interim school results may be relied on.

8. Conclusion

It seems obvious that the South African public higher education sector has no choice but to balance access and retention targets. As was plain from the background discussion and the data presented in this paper, a noteworthy number of students admitted to Universities and Universities of Technology in South Africa are not sufficiently academically prepared for tertiary education. Thirty-two percent of first-time-entering engineering students in the studied sample passed less than 50% of their subjects during the first year of study, leading to academic probation and ultimately to dropping out, forced withdrawal, disillusionment and significant economic loss for all concerned – family, the university and the national economy. Since NSC Mathematics and Physical Science scores remain statistically the most significant indicators of success in the first year, it is not difficult to contemplate that an improvement in secondary education in South Africa will minimise this loss.

Since the combined effect of admitting increasing numbers of underprepared students in an effort to meet government targets for providing access to previously disadvantaged students while attempting to stay financially viable as an institution have a direct, detrimental influence on retention, admission policies should be revised to correlate access and enrolment targets with retention targets. The authors are currently investigating the development of an optimal admission policy for engineering technology students. Additional tests used in this study have not revealed more than could be inferred from the final NSC results, but it is envisaged that admission tests will be part of such a policy, at least until such time as interim school results become more reliable.

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