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**The Critical Voice of Successful
Students in the Strategies of
Resolving the High Drop-out Rate
in Engineering Studies**

Dudu Mkhize

**Faculty of Engineering, University of
Johannesburg, Johannesburg,
South Africa**

Athens Institute for Education and Research
8 Valaoritou Street, Kolonaki, 10671 Athens, Greece
Tel: + 30 210 3634210 Fax: + 30 210 3634209
Email: info@atiner.gr URL: www.atiner.gr
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The Critical Voice of Successful Students in the Strategies of Resolving the High Drop-out Rate in Engineering Studies

Dudu Mkhize

**Faculty of Engineering, University of Johannesburg
Johannesburg, South Africa**

Abstract

The promulgation of the constitutional right to freely choose occupations and professions for all South African citizens has opened access for African black youngsters to study engineering. Job Reservation Act barred African blacks to study and become engineers. National research reveals access has not resulted into success in engineering studies. Factors leading to this include cognitive ability. According to Loji (2012) the significant numbers of South African students lack problem solving skills in engineering studies. Socio economic factors are also viewed as the culprit resulting in the poor quality of education for impoverished students. Yet other researchers blame the poor predictive validity of the National Senior Certificate examinations (NSC), which is used for admission to the universities. Currently, there is a national preoccupation to find solutions to curb the unacceptable failure rate for students. Typical to the South African legacy, the voices of the black students have been ignored. This paper is based on the study that aimed to investigate the voice of successful engineering students regarding a testing for cognitive ability as an alternative to admit students with potential to succeed in engineering. The study found that NSC is viewed by students as fair for all. Students were opposed to testing for potential as to them, this is prone to a built in bias against other races. Finally, students confirmed the theories for researchers like, Pintrich (2003), that is, motivation and not cognitive ability explains academic achievement. Further studies based on the findings are recommended.

Keywords: Engineering studies, engineering students, academic achievement, academic potential tests, students' failure, academic motivation

Corresponding Author:

Background and Context

Admission to engineering studies for the South African youth of all races signalled a demise of the Job Reservation of 1926 and Bantu Education Act of 1954. The former excluded Blacks from professions such as engineering and actuarial science, whereas Bantu Education Act of 1954 (Verwoerd, 1954:7, 15 & 25) deliberately provided inferior education to blacks which ensured they could never qualify to study engineering. Currently, the black youth is flooding engineering programs in the country's universities. However, this has not translated to more black students graduating in engineering. In fact, their failure rate is higher than 60% (Department of Higher Education, 2010) and (Fletcher, 2011). It is therefore, a national challenge to address the low throughput of engineering students. Clearly, strategies being explored incorporate the perceived factors behind the students' failure. The following section reviews these factors.

Literature Review

Factors resulting on high dropout and failure rate

Cognitive ability of students seems to be viewed as the main factor for the students' failure. For example, Loji (2012) asserts that the significant numbers of South African students lack problem solving skills in engineering studies, making it difficult for them to succeed. Also, van Eeden, de Beer and Coetzee (2001) argue that cognitive ability and learning potential are predictors of academic achievement by engineering students. This implies that the students' cognitive ability and learning potential are questionable! The second factor is low socio economic conditions; resulting to poor schooling and inadequate preparation for university studying for impoverished students. (Nel, Troskie-de Bruin & Bitzer, 2009). In response to this a number of special programs have been designed and implemented in most universities. These were in preparation for engineering and science studies at the universities. Examples include the Science Foundation programme (Grussendorf, Liebenberg & Houston, 2004). The final cited culprit for the high failure and dropout rate is the mismatch between grade 12 results and academic performance at the university (van der Merwe & de Beer, 2006). This means the National Senior Certificate examinations (NSC) has been found to be a poor predictor of first year academic success at the university (Nel & Kistner , 2009). Admission to South African universities is based on students' performance on NSC examinations which are national and common for all students in their final year of high school. The view of NSC as a poor predictor for success at the university has kindled a debate whether it is an appropriate sole entry requirement for the university. Therefore, strategies to compliment NSC as an entry requirement to the university have been initiated as a strategy to resolve the failure problem.

Strategies to Resolve low academic achievement.

There are two strategies that are seen as having the potential to resolve the problem at hand. Both are based on cognitive abilities of students. The first is the use of the dynamic assessment to assess academic potential for students (De Beer, 2000). Unlike psychometric testing which is static, dynamic assessment incorporates training into the assessment process in an attempt to evaluate not only current level of cognition, but the potential future level of ability. Attesting to this Foxcroft & Roodt (2011: 128) state; ‘the focus is on identifying potential and providing learning opportunities to help individuals improve their level of cognitive functioning’.

Albeit the incorporation of training, dynamic testing has its roots in psychometric testing which according to Ntwampe & Ndlela (1995:2) was fraught with racial discriminating behaviours in education. ‘In psychometric testing, we have witnessed racism unprecedented in the history of mankind. Some of the instruments and techniques were and are designed with the purpose of excluding “other people”. Nothing tells us the divine mission of psychometrics is over and has changed’. Foxcroft and Roodt (2011) testify to these allegations stating that psychometric researchers used this to justify Bantu Education. Another strategy which is currently being implemented nationally in many universities, is the National Benchmark Tests (NBTs) Project. The cited objective of NBTs is to assess the academic readiness of first year university students as a supplement to secondary school reports including the grade 12 results. These tests are administered under standardized testing conditions (<http://www.nbt.ac.za>). Results from NBTs are used to inform learners and universities about the level of academic support that will be essential. Currently, NBT are not used to admit or reject students at the universities.

The omitted factor in the strategies

Both strategies are based on the cognitive abilities and cognitive functioning or potential of students who access universities. This preoccupation with cognitive ability of students is opposed to the current research that has continuously linked academic achievement with motivation. For example, Pintrich (2003:671) assert that self-efficacy of students is a predictor of their academic achievement ; ‘students who believe they are able and that they can, are more likely to be motivated in terms of effort, persistence, and behaviour than students who believe they are less able.’ Self-efficacy and goal theory are motivation constructs (Bong (2001:23). The well documented outstanding academic achievement of students in Asia, both national and international compared with their counterparts in the West has received much attention (Hau & Ho, 2008). Finally, research has shown that academic motivation has different manifestations in different cultures (Maerhr, 2008 and Chang & Wong, 2008). It may well be that academic motivation for students have dynamics peculiar to the country’s multi-cultural society! Finally, despite the outcry on the high failure rate, some black students succeed against odds! The

lessons from these students may have a lot to contribute towards resolving the failure problem.

Justifying the Voice of Students

The majority of university students are late adolescents. Recent research points out to the positive developments among adolescents, in particular their cognitive development. For example, Benson (2007:33) espouses a model of viewing and researching positive youth development as developing assets. Cognitive growth accomplished by learners during adolescence is a major asset. Coleman and Hendry (2004: 36) claim that there is improvement in attention, both short and long term memory for adolescents. Harris and Butterworth (2002:306) argue that adolescence is marked by new forms of systematic thinking which includes capacity for abstract thinking. Adding to the above cognitive abilities that come with adolescence, Lefrancois (2001: 488) and Berk (2005:365) claim that adolescents have advanced meta cognitive skills and their cognitive self-regulation improves.

Berk (2003: 363) further elaborates on hypothetico-deductive reasoning as follows: 'When faced with a problem adolescent's start with a general theory of all possible factors that might affect the outcome and deduce from its specific hypothesis or prediction about what might happen. Then they test these hypotheses in an orderly fashion to see which ones work in the real world'. All this, seem to be in contradiction with the doubts being cast on the quality of cognitive ability of university students, who happen to be adolescents!

Another justification comes from the study of coping strategies by adolescents in 22 countries which found that the majority of South African adolescents use active and internal coping in the face of challenges (Gelhaar, Seiffge-Kreneke, Bosma, Cunha, Gillespie, Lam, Loncaric, Macek, Steinhausen, Tam and Winkler-Metzge (2004). This placed South African youth on par with the youth in Hong Kong who are known to have a very high academic achievement.

Aim for the Study

This study aimed to investigate the voice of successful students in engineering despite having all the attributes which puts them at risk for failure and drop out at the university. The main risk being that they are from impoverished families and schools. These students are according to Wood & Graham (2010) of interest in addressing the 'why'? This focuses on the resilience rather than the risk. However, for the purpose of this study the investigation of the voice of these students focuses on their perspectives regarding the current national developments on the entry requirements for accessing university studies.

Method

Participants

Qualitative research method was adopted for the study as it is concerned with understanding social phenomena from participants’ perspectives (McMillan & Schumacher, 2006:315 and Denzin and Lincoln , 2008:4). Criterion sampling (Onwuegbuzie & Collins, 2007:286) was used to select a sample of successful students in engineering. Twenty students who met the following criteria volunteered to participate in the study.

- black students from impoverished families and schools,
- students with average grade 12 results and
- final year engineering students with a good academic record in their engineering studies.

Students have to have an average of 32 APS in their grade 12 results to be admitted to a four year degree in civil or electrical and electronics or mechanical engineering at the University of Johannesburg. Table 1 and 2 gives APS for the sample’s grade 12 results used to admit them in engineering studies.

Table 1: *Calculation of the Admission Point Score (APS)*

APS Scale	7	6	5	4	3	2	1
Percentage	80-100%	70-79%	60-69%	50-59%	40-49%	30-39%	0-29%

Over and above obtaining the average APS, they have to have at least 60% in mathematics and science.

Table 2: *Admission Point Scores of Participants*

<i>Student</i>	<i>APS</i>	<i>Student</i>	<i>APS</i>	<i>Student</i>	<i>APS</i>	<i>Student</i>	<i>APS</i>
1	32	6	32	11	32	16	37
2	35	7	32	12	30	17	33
3	35	8	37	13	32	18	32
4	36	9	37	14	32	19	32
5	34	10	34	15	38	20	38

Procedure

Focus group interviews were chosen as a method of interviewing as it brings about a range of advantages such as the production of amounts of qualitative data that would be less accessible without the interaction found in a group (Morgan, 2001:141). Hence, these were semi-structured interviews that involved guiding questions but allowed participants to express their opinions (Willis, 2007: 3). The first guiding question was; ‘What are your perspectives or opinions on the use of grade 12 results as entry requirement to study engineering at the universities’. The second question was, ‘What are your

perspectives or opinions on the additional use for entry requirements of tests that assess the potential for prospective students to succeed in engineering studies?' The sample of twenty was divided into four groups of five students.

Data Analysis

Global analysis of qualitative data was employed. According to Henning (2004: 109) the global analysis of qualitative data looks at data in an integrated manner as opposed to fragmented codes. Hence, the very structure of data from interviews and accompanying notes is seen as the organising logic or themes for data. In other words, the priority in data analysis was placed on understanding the participants' voice not just finding themes. This represents a shift from organizing transcripts into themes right away (Chase, 2008:73). Also, this is an attempt to avoid the conflict between researcher's interpretation and what participants said (Borland, 2004: 522). After a global analysis of the participants' voice, translation of these into themes was finally done. Tables 1 and 2 illustrate these themes with the best quotations from the participants which elaborated the themes.

Results

Perceptions the use of grade 12 results to access engineering studies

Participants expressed positive opinions on the use of grade 12 results as a criterion for selecting students to study engineering. Three themes kept coming up in the discussions of the first guiding question and these are in Table 1 with The first was the fairness to all students as all write the same examinations at the same time, even though in different locations. To students using the same examination results to access university is tantamount to using the same standards for all students; 'Final grade 12 results are based on a nationwide standard'.

The theme motivation means that preparation for grade 12 examinations was viewed by students as a motivation to work hard in high school, so as to get good marks that will enable them to access engineering programmes at the university. In fact, some felt, grade 12 results are an incentive to work hard during the earlier years of schooling, so as to get good results in the final year; 'From my perspective learners will get used to working hard from early grades for preparation of grade 12'. The final emerging theme indicated that students strongly believed that grade 12 results are reflective of their aptitude, potential and preparation for tertiary studies.

Perceptions on assessing for potential

In general, students felt strongly against these tests. They felt these tests may be biased against other races; 'Why should you be subjected to assessment which may be biased to certain races?', also, 'These tests usually have a built in bias.' In their opposition to assessing for potential, motivation came up ; 'If an individual wants something bad enough he will make it happen no matter

what” and ‘I strongly disagree as I believe it is up to the individual to decide what they want to do.’ Finally, participants reiterated what had already been said in about the use of grade 12 results for university access; ‘I feel everyone who passes matric has a chance for greatest success, subjecting those who passed to assessment may take away their chances.’

Table 3. *Perceptions on the use of grade 12 results to access engineering studies.*

Themes	The voices of students
<p>THEME 3.1</p> <p><i>Fair means of selection for tertiary institutions.</i></p>	➤ “I see no problem with it. Final grade 12 results are based on a nationwide standard so everyone has the same opportunity”.
	➤ “I feel it is a fair criteria as all of us are judged in the same way. No one gets an advantage because of their better school”.
	➤ “It is a very appropriate and fair process and I see no other fair viable option to replace it”.
	➤ “I feel confident about the grade 12 results for being selected at the university”.
	➤ “Its good as the prospective students needs to perform in school to ensure being admitted at the university.
<p>THEME 3.2</p> <p><i>Motivation</i></p>	➤ “Students in high schools know that they have to pass mathematics and science to be admitted to engineering and they become motivated to work hard”.
	➤ “From my perspective learners will get used to working hard from early grades for preparation of grade 12”
	➤ “I feel the grade 12 results given an indication of the applicant’s aptitude, which needs to be understood.
<p>THEME 3.3</p> <p><i>Reflects aptitudes, potential and preparation for tertiary studies</i></p>	➤ “I strongly feel that students can display their potential through their matric results and aptitude. This might not be a definite indication whether they will succeed or not but it is a start of success identification then of course after that it’s up to the individual”.
	➤ “I feel that it is adequate since it best reflects the students’ abilities”.
	➤ “I think it is very good as these results best reflect a high school student’s preparation for their tertiary education”.

Table 4: Perceptions on assessment tests for potential in engineering studies

<p>Theme 4.1</p> <p>It is all about academic motivation</p>	<ul style="list-style-type: none"> ➤ “If an individual wants something bad enough he will make it happen no matter what” ➤ “It is all about motivation. After being accepted to the university, you need to do your best”. ➤ “I strongly disagree as I believe it is up to the individual to decide what they want to do”. ➤ “Success is not determined by assessment tests result. Success is determined by the drive and perseverance of the student”. ➤ “The motivation to work can be seen from school results and this is what counts for success at the university”
<p>Theme 4.2</p> <p>May be biased against other races</p>	<ul style="list-style-type: none"> ➤ “Why should you be subjected to assessment which may be biased to certain races”? ➤ These tests usually have a built in bias. They attempt to assess cognitive ability and spatial reasoning, but the testing instrument may not necessarily effectively assess these attributes”. ➤ “Students who do not have access to libraries in the community or school and who do not come from a background where stimulation was given, do not perform as well in these tests” ➤ “Students coming from the disadvantaged backgrounds will be negatively affected since they don’t have necessary skills required to pass aptitude tests” ➤ “I don’ think this kind of selection process will work as you won’t know who will have the greatest chance of success and then you could say no to someone that could pass everything and yes to someone who will drop out and fail. I think this selection may not be the most accurate”.
<p>Theme 4.3</p> <p>May sabotage equal chances for all</p>	<ul style="list-style-type: none"> ➤ “I feel everyone who passes matric has a chance for greatest success, subjecting those who passed to assessment may take away their chances”. ➤ “Each student should have equal chances as at that age they are still developing” ➤ “Everyone has must have the same chance of proving their worth, Many students have untapped potential and can perform brilliantly if given an opportunity”

Discussion

It is noted that this study was qualitative in nature and hence, generalisations cannot be made based on the findings.

The respondents' high regard for grade 12 results as the entry requirements into engineering is in line with the fact through these, they gained access to engineering studies and subsequently are achieving in their studies. To them their high school results were reflective of their academic potential at the university and in particular in engineering studies. Researchers in the neighbouring would agree as found a positive relationship between school achievement and university achievement for Zimbabwe youth (Chireshe, Shumba, Mudhovozi & Denhere, 2009). While this finding does contradict the general outcry for the mismatch between high school results and academic achievement at the university, it cannot be used as generalisation because of the qualitative nature of research. However, this may be indicative of salient factor other than high school results. Expounding on this in the American context, Wood and Graham (2010:176) state that the resilience rather than risk focuses on why is that many African American youth developing in high risk settings are doing well academically at the universities? Another finding in this study is the opposition of successful students towards assessing students' potential. These students actually freely provided an omitted factor for success in engineering studies, namely academic motivation! To these students, high school results are motivating students at the high school level. At the university, academic motivation is all they need because grade 12 had already affirmed their academic potential. This is in line with the current explanation for the academic achievement gap according to Chen, Stevenson, Hayward & Burgers (1995). These researchers argue that decades of explaining achievement in terms of cognitive are no longer popular as these tended to explain these in terms of genetic differences among races. Instead Chen et al (1995) proposes a cultural academic achievement model. This places cultural values and beliefs, social support as interacting factors that results into students' motivation behaviours such self-concept, attitude which in turn results into academic achievement. Finally, the belief that tests to assess potential usually have a built in bias against other races reflects the prevalent legacy of the country racial discrimination, despite the fact that constitutionally this is illegal. This is not far-fetched considering researches in countries which have experienced decades of racial discrimination indicate that these are very resilient. Seaton, Caldwell, Sellers & Jackson (2008) found that most African American youth have had face to face racial discrimination. Also Eccles, Wong & Peck (2006) found that many African American perceive racial barriers to upward educational and occupational mobility. It is of interest that the biases may not only be coming from outside, but it may be internalised by groups who have experienced this over a very long time. This was shown by a series of studies with Black and White students attending Stanford University where Black students performed poorly in a standardized test if told the test was diagnostic of their abilities, but when told the test was a problem –solving

activity unrelated to their ability , their permanent was similar to the White students(Steele & Aronson,1995). Also , the low throughput rate in engineering programs is not a unique problem to South Africa as Moses, Hall, Wuensch, Erquidi, Kaufmann, Swart, Duncan and Dixon (2011) seek resolution for retention of engineering students in the role played by the personalities of students , rather than focusing on cognitive aspect only. Based on these findings, recommendations of longitudinal studies both locally and nationally, that will investigate academic motivation of students of black students from socio economic backgrounds who perform well in high school and gain entry to engineering studies. Outstanding academic performance in high school seems to indicate there is nothing wrong with their cognitive ability. Other factors may be at play!

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