Predicting success among prospective disadvantaged students in natural scientific fields[1, 2]

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Abstract

One hundred and fifty-nine Grade 11 prospective disadvantaged students in the natural sciences at the University of Pretoria completed the Study Orientation Questionnaire in Mathematics and the Senior Aptitude Test (Advanced). Fifty-nine male students (M age = 16.05; SD = .57) and 100 females (M age = 16.02; SD = .512) scored significantly differently on three subtests, Non-Verbal Reasoning, Calculations, Spatial Visualization and in Grade 11 mathematics. Stepwise linear regression showed a combination of subtests of the Study Orientation Questionnaire in Mathematics and the Senior Aptitude Test (Advanced) contributed significantly (R^2 = 15.7% and 20.8% respectively) towards predicting the Grade 11 mathematics and physical sciences marks of prospective students.

Inadequate achievement in mathematics and physical sciences at school and at university, as well as low throughput rates of students in the natural sciences (mathematics and its application in science, engineering and technology) in particular (a perennial problem in South Africa) have a ripple effect. Black students are particularly disadvantaged, it seems: close to 40 per cent of all first-year students fail their first year of study (especially learners from traditionally disadvantaged communities) (Mkhabela 2004; Pandor 2005; 2008). Due to the fact that marks obtained in Grade 11 still determine to a great extent whether learners will be accepted for further study at universities (Sibaya and Sibaya 1997; Jita, Maree and Ndlalane 2007), fields of study in the technological and natural domains in particular are to a large extent out of reach for Black learners. Black students studying at the University of Pretoria, especially in the natural sciences, generally stand a smaller chance of passing than other students (Bureau for Institutional Research and Planning 2001). In addition to impacting negatively on university study, inadequate achievement negatively affects the national economy (Simkins, Rule and Bernstein 2007). The

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extent of the effect of students' inadequate achievement on the economy is practically incalculable and may have major consequences for a developing country such as South Africa.

South African universities are therefore compelled to reflect continually and innovatively on their nature and objectives (including issues such as the way in which prospective students are selected for certain fields of study, as well as the support that is given to university students) in an attempt to prepare students more adequately for a rapidly changing world. It is imperative not only to increase the number of Black students (females in particular) studying in these fields of study at the University, but, more importantly, to ensure a higher throughput rate for these students.

In an attempt to address these issues, over the past several years in South Africa, education and training at school level have been transformed and reorganised. The introduction of an Outcomes-Based Education (OBE) system in 1994 was widely welcomed. However, for a number of reasons, this system has failed to deliver the desired results. Universities have consequently become less willing to use Grade 12 results as the main criterion for selection to study at university level. Most authors (Bloch 2009; Christie, Butler and Potterton 2007; DoE 2001; Fleisch 2008; Motala and Pampallis 2005; Maree 2010) agree that the thoughtless introduction of an OBE teaching philosophy has left teachers unprepared to teach the new curriculum and has impacted negatively on the achievements of disadvantaged learners in particular. Whereas the idea appeared laudable on paper, OBE was introduced long before the necessary steps had been taken at ground level to ensure its successful implementation (that is, to the extent that successful implementation of this education system was possible in South Africa).

Given the scenario outlined thus far, it seems vital to apply well-researched, well-designed, valid and reliable strategies relevantly to ensure that valid and reliable predictions can be made. Despite the fact that academics have been struggling with the issue of identifying valid, reliable and defensible admission criteria to select students for admission to fields of study so that these students succeed in their studies for a long time, there still seems to be insufficient agreement on factors that predict academic success, especially at university level (Bellar 1994; Wedman 1994; Huysamen 1997; Maree and Eiselen 2007; Maree, Van der Walt and Ellis 2009). It is however, agreed that no single test or admission mechanism will predict academic success beyond a moderate level. Psychological tests are only useful if they are used in combination with other methods (including narrative assessment techniques) and results should be evaluated from a holistic perspective to ensure that a more complete overall picture of an individual is obtained. Pitt (2002) for instance argues that university students need an array of skills, including proven achievement, aptitude, and motivation to succeed. Nonetheless, uniformity as regards the 'precise' nature of admission criteria and tests is still lacking. Across the world, universities expect prospective students to take Aptitude Tests to determine whether they will be accepted for enrolment in courses of their choice. However, in South Africa Grade 12 marks still seem to be the best predictor of success at university with the results of aptitude tests being the second best predictor (Huysamen 1999) (it should be noted, though, that this research was conducted on students who still wrote the 'old' Grade 12 examination). Here, too, however, it seems important to be extremely careful. Foxcroft and Stumpf (2005) argue that Grade 12 results do not predict university achievement for Nelson Mandela Metropolitan University students. Grade 12 results seem to be less accurate for Black than for white students. In addition, because assessment characterises learning programmes, success in examinations is often achieved by parrot-style learning instead of critical and possible even creative thinking. If so, success reflects primarily the diligence of learners and their teachers, rather than quality learning experiences in school.

Understandably, therefore, a range of criteria, instead of focussing on finding a single predictor of success at university, are being investigated around the world to determine admission to universities. Many researchers have argued convincingly that a combination of achievement at high school and admissions tests scores predict success at university more accurately than when possible predictors of university success are considered in isolation (Ramist, Lewis and McCamley-Jenkins 1994; Huysamen 1997). A word of caution seems in order at this stage. Whereas Grade 12 examination marks are typically included in admission strategies, some researchers (Mitchell and Frijdohn 1987; Maree, Pretorius and Eiselen 2003) have argued that there is insufficient evidence to suggest that the inclusion of Grade 12 marks ensure more accurate and fair admissions procedures at universities and ensure that selected students actually possess the types of skills that are essential to succeed at university.

In addition to what has already been said, it seems essential to devise and implement strategies to ensure effective teaching and successful learning; crucial elements to ensure success at a university. Some researchers (e.g. Visser 1989; Cobb, Wood, Yackel and Perlwitz 1992; Fortunato, Hecht, Tittle and Alvarez 1991; Reynolds and Wahlberg 1992; Wong 1992; Van Aardt and Van Wyk 1994; Maree, Prinsloo and Claassen 1996; Van der Walt, Maree and Ellis 2008) have found a statistically significant correlation between academic achievement and aspects of students' study orientation, including study attitude, the use of meta-cognitive learning strategies, effective time management, the will to achieve, parents' expectations as well as students' milieu of learning in general. Meta-cognition includes inter alia prediction (of own ability to solve a problem), monitoring (of own behaviour), assessment (of own progress), as well as reflection (the ability to explain why learners make particular mistakes). In essence, this amounts to learners' awareness of (the necessity of) timely and on-going regulation and reflection in respect of their cognitive processes.

Since professionals at the University of Pretoria are unanimous in expressing the view that fair and effective selection mechanisms must be developed to increase the number of Black students in particular who study in natural scientific fields, and to increase the low pass and throughput rates, the main thrust for the current research was to contribute to strategies for the selection of Black students (females in particular) who will study successfully.

Despite what has been stated earlier in this article, the Grade 12 qualifying marks in South Africa, which reflect a student's achievement in the school-leaving examination, remain the determining factor as regards admissions (UP 2011). A student's 'Admission Point Score' is the sum of scores for the student's six best courses (excluding Life Orientation, which is compulsory but does not count for purposes of calculating the Admission Point Score: see Table 1) at the end of Grade 12. University entrance requirements in South Africa may include certain subjects from a designated list. Courses taken also have to conform to certain formulae, with different faculties having different entrance requirements. Each faculty sets minimum Admission Point Score requirements for admission to different fields of study in the faculty. While a student's Grade 12 marks still remain the determining factor as regards admission (and constitute by far the most widely accepted admission criterion at universities), the University of Pretoria (like universities across the country) expects students to write an entrance test as well. However, while some faculties have made it compulsory for students to write an entrance test, others (for the time being at least) only recommend that students write an entrance test.

Table 1: Calculation of a student's admission point score at the University of Pretoria

Letter grade obtained in Grade 12	Achievement
A	7
B	6
C	5
D	4
E	3
F	2
G	1
Maximum score	42

In the current study, the difference in achievement between gender groups in the so-called Junior Tukkie programme (a programme aimed at recruiting promising students to study at the University of Pretoria) was investigated in terms of Senior Aptitude Test (Advanced) scores (Owen 1999) and scores on the Study Orientation Questionnaire in Mathematics (Maree et al. 1996). In addition, predictabive value of these scores was investigated. The difference in achievement (Grade 11 marks in mathematics and physical sciences) by gender, as well as the predictive value of the two tests for the two groups taken together, was examined. The aim was to develop an alternative mechanism for predicting success among these students and, possibly, those at other universities. Hypotheses were:

- that the difference between the mean scores of the two sets of tests for gender groups would be significant;

- that scores on subtests of the two tests and the marks of prospective students in mathematics and physical sciences would be correlated; and
- that a combination of subscale scores on the tests would best predict the marks of prospective students in mathematics and physical sciences.

METHOD

Sample

A sample of 159 disadvantaged Grade 12 students from feeder schools who had achieved at least 60 per cent in mathematics and physical sciences in their Grade 11 examinations in 2009 and who had expressed an intention to study in natural scientific fields was invited to attend a winter school lasting five days at the University of Pretoria in April 2010. All these students are Black and the majority are female so this project reflects the University's aim to increase the number of Black students (females in particular) that enrol in natural sciences so that students reflect the demographics of the South African population.

Ethical aspects

Permission was requested and obtained in writing from the Departments of Education, participating schools and students and their parents to conduct the research and publish the findings. Assurance was given that no individual would be identified.

Limitations of the study

This was a limited, local study, and the findings reported in this article have limited generalisation.

Tests

The Study Orientation Questionnaire in Mathematics (Maree et al. 1996)

This questionnaire comprises six subtests containing 92 statements that relate to how individuals feel or act regarding aspects of their achievement in mathematics. The test was developed by the Human Sciences Research Council of South Africa (Maree et al. 1996) between 1994 and 1997 based on responses from 3013 high school students in South Africa. (See Table 2).

Table 2: Sample item by subtest of the study orientation questionnaire in mathematics

	Subtest	Sample item from each area
1.	Study attitude in mathematics (SA)	I try to be interested in mathematics tests and exams, even if it seems more enjoyable to do something else
2.	Mathematics anxiety (MA)	I cannot speak clearly when I suddenly have to answer a question in a mathematics class
3.	Study habits in mathematics (SH)	I ask questions and take part in discussions during mathematics lessons
4.	Problem-solving behaviour in mathematics (PSB)	I try to carry out the following four steps for problem solving in mathematics: find out what is given and asked; make a plan; carry out the plan; and verify the solution
5.	Study milieu in mathematics (SM)	I cannot see or hear well in the mathematics class, but I hesitate to mention it to my teacher
6.	Information processing in mathematics (IP)	My mark in geometry is lower than it should be because I cannot apply certain theorems during mathematics tests and examinations

Study attitude (14 items) deals with feelings (subjective and objective experiences) and attitudes towards mathematics that affect students' motivation, expectation and interest with regard to mathematics. Mathematics anxiety (14 items) concerns an 'uncomfortable' feeling about mathematics and manifests in aimless behaviour (like excessive sweating, scrapping of correct answers and an inability to formulate mathematical concepts). Study habits (17 items) address the displaying of acquired, consistent and effective study methods. Problem-solving behaviour (18 items) includes cognitive and meta-cognitive strategies in mathematics. Study environment (13 items) includes aspects relating to the social, physical and experienced environment. Information processing (16 items) reflects on general and specific learning, summarising and reading strategies, critical thinking and understanding strategies like optimal use of sketches, tables, and diagrams.

The learner rates each item on a 5-point response format anchored by 0 'Rarely' and 4 'Almost always'. Forty-six of the items are stated positively and 46 stated negatively to avoid a 'yes' set. Information on the answers can be converted to percentile ranks and a profile can be drawn.

As a broad guideline for the interpretation of a profile the following division is suggested: 70-100 per cent (adequate study orientation), 40–69 per cent (neutral but can contribute to an adequate or inadequate study orientation) and 0–39 per cent (inadequate study orientation).

In this and earlier studies the Cronbach alpha reliability coefficients for the different subtests of the questionnaire ranged from .70 to .80. and for the questionnaire as a whole from .89 to .95. The following steps (Maree 1999) were followed to ensure content validity: an extensive literature study was undertaken, various experts checked the phrasing and assignments of items to subtests, the item-subtest correlations were checked, and care was taken that the most important aspects of the different subtests had been accounted for. Items were eliminated that did not correlate at least .20 or higher with the total score for all items in their subtest for at least each of three language groups, and an item was kept in a specific subtest only if it correlated more strongly with that subtest than with any other subtest.

The Senior Aptitude Test (Advanced) (Owen 1999)

This test has ten subscales: Vocabulary (30 items), Verbal reasoning (25 items), Nonverbal reasoning i.e. figures (25 items), Calculations (25 items), Reading comprehension (25 items), Comparison (30 items), Price controlling (30 items), 3-D Spatial visualisation (30 items), Mechanical insight (25 items) and Memory (the testee is given a paragraph and memorises as many facts as possible). Large differences were found in test reliabilities in previous studies: reliability Grade 10 .23–.94; Grade 11 .32–.95, and Grade 12 .22–.94 (Owen 1999). Construct validity was assessed using intertest correlations. The General Scholastic Aptitude Test (Claassen, De Beer, Hugo and Meyer 1998) was used as an external test to validate the Senior Aptitude Test (Advanced). Correlations between scores on subtests and the Verbal, Nonverbal, and total scores of the General Scholastic Aptitude Test ranged from .41 to .96, supporting the assumption that there is construct validity (Owen 1999).

Criterion variables

The marks of learners in mathematics and physical sciences serve as criterion (dependent variables to be predicted) for the two tests referred to above.

Procedure

All 159 students completed both inventories in a single day (one sitting) in April 2010. The purpose of the testing was explained, and permission was obtained from the students to use their scores for research purposes.

RESULTS

Altogether 100 of the 159 students were female and 59 male. Table 3 presents the Pearson product-moment correlations $r_{x,y}$ among students' scores on the Senior Aptitude Test (Advanced) and the Study Orientation Questionnaire in Mathematics and marks in mathematics and physical sciences (criterion). Correlations were significantly different from zero for a number of subtests, albeit small.

Table 3: Pearson correlation coefficients among students' scores on the Senior Aptitude Test (Advanced) and the Study Orientation Questionnaire in Mathematics and marks in mathematics and physical sciences (n =152)

Senior Aptitude Test (Advanced)	**Mathematics**	**PSciences**
Subtest		
Stanine T1: Vocabulary	.142	.342**
Stanine T2: Verbal reasoning	.107	.233**
Stanine T3: Non-verbal reasoning	.172*	.118
Stanine T4: Calculations	.273**	.252**
Stanine T5: Reading Comprehension	.134	.228**
Stanine T6: Comparison	.123	.214**
Stanine T7: Price Controlling	.157	.150
Stanine T8: Spacial 3-D	.038	.003
Stanine T9: Mechanical Insight	.161*	.123
Stanine T10: Memory	.139	.218**
Study Orientation Questionnaire in Mathematics		
Study attitude in Mathematics (SA)	.294**	.307**
Mathematics anxiety (MA)	.177*	.239**
Study habits in Mathematics (SH)	.244**	.260**
Problem-solving behaviour in mathematics (PSB)	.211**	.168*
Study environment (SM)	.252**	.305**
Information processing in mathematics (IP)	.277**	.275**

* p< .05; ** p < .01

(Two-tailed) t-test comparisons between male and female groups on the Senior Aptitude Test (Advanced), the Study Orientation Questionnaire in Mathematics subtests and marks in mathematics and physical sciences appear in Table 4. Statistically significant differences were found between males and females only for Non-verbal reasoning, Calculations and Spatial visualization ($p < .05$). Table 4 further shows that the mean mark in mathematics for males was significantly higher than for females. All effect sizes were small.

Table 4: (Two-tailed) t-test comparisons between male (n = 59) and female (n = 100) groups on two measures and marks in mathematics and physical sciences

Senior Aptitude Test Advanced	**t**	**mean difference**	**SED**	**p**	**effect size (d)**
Stanine T1	-.729	-.285	.391	ns	
Stanine T2	-1.355	-.416	.307	ns	
Stanine T3 (Non-verbal reasoning)	2.453	.768	.313	.015*	0.20
Stanine T4 (Calculations)	2.229	.792	.355	.027*	0.18
Stanine T5	-.533	-.181	.340	ns	
Stanine T6	-1.085	-.332	.306	ns	
Stanine T7	-1.433	-.459	.321	ns	
Stanine T8 (Spatial visualisation)	1.664	.569	.342	.098+	0.14
Stanine T9	-.789	-.242	.307	ns	
Stanine T10	.691	.205	.296	ns	
SA	-.508	-2.111	4.158	ns	
MA	.567	2.653	4.681	ns	
SH	.273	1.068	3.904	ns	
PSB	1.278	4.840	3.787	ns	
SM	-.357	-1.521	4.262	ns	
IP	1.359	5.297	3.897	ns	
Mathematics	1.624	3.999	2.462	.106+	0.14
P Sciences	.774	2.139	2.766	ns	

* p< .05, ** p< .01
+ Moderate evidence of significant difference

To assess the predictability of students' mathematics and physical sciences marks from the subscales of the two tests, separate stepwise linear regression analyses were utilised. The overall regressions were statistically significant ($F(1,151)=14.326$, $p<0.001$ for mathematics as dependent variable; $F(1,151)=20.020$, $p<0.001$ for physical sciences as dependent variable). It was found that Study attitude is a significant predictor for both mathematics and physical sciences marks, while Calculations is a further predictor for mathematics, and Vocabulary for physical sciences.

Table 5: Stepwise linear regression analysis for subtests of the Study Orientation Questionnaire in Mathematics and the Senior Aptitude Test (Advanced) as independent variables and mathematics as the criterion for all participants (n=152)

	B	SE B	ß
Constant	55.220	4.097	
SA	.170	0.045	.286**
Stanine T4	1.849	.525	.264**

$R^2 = 0.157$
* p< .05, ** p< .01

The estimated regression equation for the prediction of students' mathematics mark at the end of Grade11 is ^{Y}mathematics = 55.22 +.17·XSA + 1.85·XT4 where XSA is Study attitude in mathematics and XT4 is Calculations. This implies that the mathematics mark increased with a more positive attitude towards mathematics and an increasing skill in calculation. However, only a moderate 15.7 per cent of the variance in mathematics marks is explained by these two subscales.

Table 6: Stepwise linear regression analysis for subtests of the Study Orientation Questionnaire in Mathematics and the Senior Aptitude Test (Advanced) as independent variables and physical sciences as the criterion for all participants (n=152)

	B	SE B	ß
Constant	38.68	4.65	
Stanine T1	2.187	.473	.336**
SA	.190	.046	.301**

$R^2 = 0.208$
* p< .05, ** p< .01

The estimated regression equation for the prediction of students' physical sciences mark at the end of Grade11 is ^{Y}PSciences = 38.68 +.19·XSA + 2.19·XT1, where XT1 is Vocabulary. The physical sciences mark hence increased with an increasing Vocabulary and more adequate study attitude in mathematics. Only 20.8 per cent of the variance in physical sciences marks can be accounted for by these two subscales.

DISCUSSION

Factors such as the ever-changing needs of South Africa's developing economy, the shortage of students who study in natural scientific fields and the need to train more students from previously disadvantaged groups (females in particular) especially in natural scientific fields, necessitate revising recruitment and selection processes and properly channelling students within tertiary institutions. The present study was motivated by a desire to shed more light on these issues.

Prospective disadvantaged students in the natural sciences at the University of Pretoria who obtained a mark of at least 60 per cent in mathematics and physical sciences in their Grade 11 examinations in 2009 attended a week-long winter school at the University of Pretoria. Female students had lower mean scores on Non-Verbal reasoning, Calculations, Spatial Visualization and a lower mean Grade 11 mark in mathematics than their male counterparts. Differences were statistically significant, providing convincing to moderate evidence (Albright, Winston and Zappe 2009) with effect sizes being small. Clearly, prospective disadvantaged female students achieved worse than disadvantaged males in subtests and school marks that are typically associated with achievement in the natural sciences (Owen 1999). Our study also supports the results of previous studies, which confirm that first-year female students are underprepared in three-dimensional spatial visualization, which significantly influences the academic performance of first year engineering students (Kaufman 2003; Mokone 2008).

Seemingly, the situation as regards student enrolment and success in fields of study in the natural sciences has not changed from the situation in the past. One should probably consider these scores and marks as diagnostic. We believe failing disadvantaged students are bright enough to succeed, but have not had adequate preparation at school mathematics. Natural sciences, which were, in the past, regarded by many as the domain of (white) men, remain dominated by males, while the majority of disadvantaged students (females in particular) still tend to try to prove themselves in other fields. Conditioning seems to amplify the problem. Visser (1989) and Maree (2008) concluded that mathematics and physical sciences were (and still are) regarded as 'male' activities. Given that parents' and teachers' expectations and encouragement are important predictors of achievement in these fields, teachers' and parents' higher expectations of boys' achievements than girls' often act as a self-fulfilling prophecy. Sibaya and Sibaya (1997), too, concluded that teachers expect boys to achieve better than girls in mathematics classes, borne out, for example, by mathematics teachers' tendency to ask boys more difficult questions than girls. Insufficient subject and career counselling at school exacerbates the problem. Disadvantaged female students should, for instance be advised about the potential value of following engineering graphics and technology in Grades 11–12 if they are interested in studying engineering.

Regression analysis showed that scores on the subtest Vocabulary, Calculations and Study attitude in mathematics had the largest associations with achievement in mathematics and physical sciences at the end of students' Grade 11 year. Perhaps these subtests could form part of a strategy for selecting students for a first-year course in the natural sciences. It needs to be stressed that regression analysis did not yield strong predictors of success in mathematics and physical sciences. Its most meaningful contribution was to highlight which predictors might make the most significant contribution to success in mathematics and physical sciences.

One may also note that students in the natural sciences who display adequate attitude towards study, have mastered basic principles and pattern-recognising skills in mathematics, and who have an adequate vocabulary, are more likely to pass. This finding is consistent with the finding of Dawes, Yeld and Smith (1999), who found that verbal ability is particularly important for students from previously disadvantaged areas who study engineering via English as a second language. Focus should also be on improving teaching and learning across South Africa but especially in rural and township schools and at university. Since achievement in the natural sciences is exceptionally vulnerable to poor instruction, these matters have to be dealt with adequately before change can be expected (Freudenthal 1980; Maree 1999).

Study skills are arguably the most important skills students require for success in school and at the university (Visser 1989; Van Aardt and Van Wyk 1994). Many of these skills may play an even greater role later because greater emphasis then rests on original thinking (De Corte 1995). Since students with a more adequate study orientation are more likely to achieve success in the natural sciences than those with a less adequate orientation, it seems reasonable to suggest that disadvantaged female students in the natural sciences in particular should receive counselling and guidance regarding appropriate study methods and habits. Instilling a positive attitude towards the study of mathematics and physical science seems like a logical starting point in this regard. Secondly, since students who are adept at doing basic calculations in mathematics (e.g. those who have mastered basic mathematical operations and who are au fait with drill work in mathematics) with a more adequate study orientation are more likely to achieve success in mathematics than those who lack basic skills in mathematics, focus in the teaching of mathematics should be on the acquisition of basic skills in mathematics. Thirdly, students with a larger contextual vocabulary seem more likely to achieve success in physical sciences than those with a smaller contextual vocabulary. This is not surprising because problems in physical science can best be solved by students who possess an adequate contextual vocabulary (id est, the limited, technical vocabulary of physical sciences). Focus should be on enhancing the basic, contextual vocabulary of disadvantaged students who take physical sciences. These students could, for instance, be provided with copies of state-of-the-art journals in the natural sciences such as Nature and encouraged to read these journals to enable them to acquire the limited, technical vocabulary of physical sciences to a more satisfactory extent. Doing so can be viewed as one way of helping students to achieve more satisfactorily in the natural sciences.

Ongoing research in this area seems essential, especially because the consequences of disproportionate ratios of males: females and white: Black students enrolling for fields of study in the natural sciences are far-reaching. Growth and development in the country can be greatly enhanced if a significant increase can be facilitated in the numbers of Black persons (females in particular) entering occupations where most shortages occur. Research about the main reasons why disadvantaged females achieve significantly poorer than boys in the subtests referred to seems particularly crucial. Furthermore, as marks in mathematics and physical sciences are critically important prerequisites for the development of any country and the single most important criterion for admission to universities in natural sciences related fields, it seems non-negotiable to improve the standard of teaching and learning to ensure that Black women take their rightful place in these fields of study. Addressing the lack of appropriate infrastructure in schools (including lack of libraries and access to the internet), ensuring that quality students are recruited to become mathematics and physical sciences teachers, facilitating teachers' understanding of the importance of ensuring that learners acquire basic knowledge related to mathematics and physical sciences at school and ensuring that parents become more involved in the teaching of their children may contribute to an improvement in the situation.

Focus should be on shifting the perceptions of parents, teachers, and career counsellors regarding the potential of all Black persons to succeed in fields requiring entry-level mathematics and physical sciences. Furthermore, curriculum and teaching in mathematics and physical sciences could be investigated at South African schools. More adequate high school and elementary school mathematics teaching seems an equally valid interpretation. In addition, the shortage of appropriately qualified teachers (especially in the gateway subjects mathematics and physical sciences) and insufficient teaching and learning support facilities at schools in disadvantaged areas (more particularly, rural and township schools) impact negatively on these students' Grade 12 marks and must be taken into account when students are selected.

The likelihood of an improvement in the situation delineated here seems good if the matters highlighted in this article are attended to.

NOTES

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