

Investigating the predictive validity of Mathematics and Science Students at University

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ABSTRACT Predictive validity of student admission is an incubator programme for producing quality teachers that can enhance performance of learner's achievement in Mathematics and Physical Sciences at Grade 12. The key issue examined in the paper is whether the admission policy used in Natural Sciences programmes has made a significant contribution to their success in career prospects. In an effort to widen understanding regarding the factors that predict the performance, prior academic achievement were examined. 17 students admitted to the Central University of Technology, Free State in the B.Ed: Natural Science programme majoring in Mathematics and Physical Science at the beginning of the 2004 academic year were sampled for the study. The results reveal that Grade 12 results pass in Mathematics and Physical Sciences had significant effect on student throughput and progress. A pass in university mathematics were associated with significantly less time before graduation, better career progression and better productivity in the teaching subjects.

INTRODUCTION

Higher Education institutions attribute the unsatisfactory performance of first-year students to inadequacies of schooling systems. This under-preparedness is therefore considered to be the main indicator of poor performance at first-year level and for undergraduate degrees in general. The question of poor performance at universities is largely attributed to inadequate schooling by most, if not all. In the light of inadequacies in schools, tertiary institutions in some countries, require students to write entrance tests to be admitted into tertiary institutions. The implication of this entrance however is that as long as students are screened for entering undergraduate courses through the admission tests, it is necessary to investigate future achievements of the students. Bloch (2009:61) argues that there is a high dropout rate in tertiary education with probably half of students never making it as far as getting their degree. In order to improve the quality of school education and consequently, to solve performance problem at tertiary level, it is necessary to provide quality teachers at the right time (CHE 2007).

In the Council on Higher Education (CHE) study it has been noted that South Africa National Senior Certificate (NSC) is highly skewed in terms of race and of poor quality (CHE 2007). The report further cites several examples to illustrate the seriousness of the challenges in

schooling. These examples include among other things the number of Grade 12 learners who succeed in the National Senior Certificate examination (CHE 2007). However, it has been argued that the students that gain entrance to university are in the top quintile of Grade 12 performers. Furthermore, there is a profound belief that students who perform in the lower quintile should be regarded as not having the potential to succeed in HEIs (CHE 2007).

Many mathematics educators are aware of the challenge of presenting subject in an interesting and entertaining manner while covering essential course content. It will be familiar to many teachers that some students transcribe lecture notes with minimal learning during the experience, claiming that the processes of simply taking notes keeps them so occupied that mathematics is not learnt. Other presenters prepare and distribute elaborate notes, but some students learn best from active participation, and removing the note-taking element leads to disengagement during lectures. Generally during a lecture as a student you have to make a choice, do I sit and listen to the lecture or do I furiously copy the notes being put up on the board in a hope of being able to understand them later? As any student knows it is almost impossible to do both. The worst thing is that if you miss an important point of a lecture which can be lost in 10 seconds of daydreaming . . . the rest of the lecture is a waste of time because you can't make the connection.

Objective of the Study

Whether Grade 12 these admission standards are meant to channel candidates into settings that match the workplace learning.

Conceptual Framework

The South African school system is producing students who do not easily succeed in Higher Education Institutions (HEIs). A study conducted by Department of Education on graduation rates in South African HEI's indicated that only 30 per cent of first-time entering students had graduated after five years of study. By the end of 2004 (five years after entering), 56 per cent had left their original institutions and only about 14 per cent were still in the system (Nel et al. 2009:974-975). This is a far cry from the changes initiated after 1994 that place a premium on well-qualified teachers who know their subject and how to teach it. Current requirements expect all teachers to have a four-year university degree. The system is oriented towards improving subject knowledge and practice.

The school-university gap however, is increased not only by the school system that produces inadequately prepared learners for HEIs, but also by universities that are ill-equipped to accommodate these learners – particularly learners from disadvantaged backgrounds (Nel et al. 2009:974-975). According to Viljoen (2005:33), universities can barely rely on secondary schools to adequately prepare learners for university. It is the universities' responsibility to facilitate the transition from school to university. Foxcroft and Stumpf (2005:18) comment that "the time is right for South African HEIs to stop moaning about matric and the poor quality of learners produced by the school system".

As National Senior Certificate results are being used as the only indicator for admission in some programmes, the need to re-examine the admission process is an urgent issue (CHE 2010). Research regarding predictive validity is quite scarce in South Africa. At the same time, the need for qualified teachers in schools requires the identification of potentially successful candidates for entry into Teacher Education programmes. It would be unsatisfactory if, in the absence of an empirical basis, admissions policies of teacher education programmes were

merely to legitimise the influx into teaching programmes, as opposed to shortages of enrolment. Bloch (2009:84) mentions that the teaching profession does not enjoy a good public image and that it does not attract high quality candidates at university level in many cases. The efficacy of the admissions policies will ultimately be tested by the quality of candidates completing their first year successfully then ultimately functioning as teachers and remaining in the profession.

Most countries have recognised the shortage of qualified teachers as a serious problem in the field of education. Countries such as South Africa, the USA, the UK, Canada and Australia, find it difficult to recruit an adequate number of secondary school students to enter the teaching profession, science and mathematics students with graduate degrees, in particular (Wang 2004). However, in the past, when teacher-training colleges had the exclusive right to train teachers in South Africa, there was no difficulty in recruiting academically able students to teacher colleges and training them.

These systems mainly adopted drill and practice approach, advocated strict control over instructional method employed and the content material presented and generally hold the intrinsic view that the computer could become someday a good replacement for books and teachers to some extent. However, skeptical educators especially holding constructivist views opposed this approach and redefined the computer's role as a tool enabling free explorations of the concepts and relations in open ended tasks void of any instructional method and content.

Teaching of Mathematics

Learning to teach mathematics depends, for example, on a person's ability to recognize number concepts such as 'two' in different settings. A person might encounter two apples, two dogs or two fingers on a hand. The two apples may be stacked in a fruit bowl or could be hanging from a tree. The common aspect of the 'two' mentioned here is the quantity of the objects, whereas the other aspects may differ. Number words are typical mathematical concepts that children first learn as a list of words with no numerical meaning. With more experience of number words in different settings, young chil-

dren become aware of different meanings in these words. It is a complex process to discern the numerical meaning and it takes several years for children to gain an understanding of the cardinality in number words and the principles of verbal counting (Smith and Hambleton 1990).

The above-mentioned ability to take another person's perspective as an essential part of the learning process raises the question of the student admitted in the teaching of mathematics qualification or career prospect.

Pedagogy of Teaching Mathematics

The main game is and always should be pedagogy — teaching and learning in the face-to-face setting of classrooms. ... At the same time, if the aim is to change student outcomes, ... the three message systems — curriculum, pedagogy, assessment — need to be brought into proper alignment for us to get desired educational results and outcomes. Research in pedagogy and school change is a high priority in many countries. Recent Australian initiatives have attempted to break down the barriers between discipline areas by promoting generic formulations of thinking, learning, and pedagogy, as well as new ways of organising curriculum and new forms of assessment. The ways in which such initiatives have dealt with the nexus between traditional discipline-based curriculum organisation and their new curriculum structures has varied, as has the extent to which disciplines such as mathematics have been seen as merely underpinning the new learning frameworks. A mathematical proof is not the same as a scientific testing of a hypothesis, which is not the same as a historical account or comparison across accounts, which is not the same as a critique in the arts or literature (Smith and Hambleton 1990).

It has been argued that a desirable goal for mathematics education would be that mathematics classrooms function as communities of inquiry. However, mathematics and philosophy are quite different disciplines and the way a community of inquiry might look in a mathematics classroom is likely to be quite different from how it might look in a Philosophy for Children lesson. For successful teaching to take place, a clear view of what is meant by successful learning in a particular discipline has to be demonstrated.

METHODOLOGY

This study focuses on situations in which 27 student's teachers were admitted to a Bachelor of Education: Natural Sciences programme for the purpose of being trained as Mathematics and Physical Science teachers, more specifically, different admission requirements and their understanding of mathematical concept or principle. The study aims to discern and thereafter discuss the strategies for learning that are essential for developing understanding of basic aspects of mathematics. For the purposes of this study, mathematics is considered to be a comprehensive phenomenon including concepts, strategies and principles used in social settings, such as when communicating or problem solving, that describe numerical, spatial or time relationships between objects and events.

Data were collected from the Central University of Technology, Free State from students enrolled in 2004 academic year for B.Ed: Natural Science programmes. The admission requirement was based on the form of Swedish scale ratings only, no psychometric test results were used further as a support tool to Swedish scale. Student-teaching grades were available for 17 initial professional teaching applicants (IPET). Of the 17 participants, 65% were coded as male and 35% were coded as female.

Procedure

The graduation throughput database of 2008 was used as a correlation with Grade 12 results of 2004 when these students were admitted. The intention was to determine if there is any gap as a result of Grade 12 Mathematics and Physical Science performances; these high quintile learners and their performance at the world of work. These correlations can be interpreted as indicators of the performance measurements towards contributing positively to the workplace.

Accordingly, the researchers examined individual student Grade 12 results in Mathematics and Physical Sciences to determine their admission status and corresponding first-year results. This assisted in determining the predictive validity; the student teaching subject was also taken into consideration. The focus of the study was on the student admitted in 2004 for B.Ed: Natural Sciences which is a four-year degree.

The researchers conducted surveys in order to gather qualitative and quantitative sources of data that would shed more light on this group of students admitted into teacher education programmes. The purpose of the survey was to gauge whether the results of Grade 12 are really able to predict the completion of studies and also assist in determining the success of students.

FINDINGS AND DISCUSSION

Seventeen questionnaires were received from first-year students; the findings are presented and discussed under the various themes in the study.

Student Admission

The criteria used in admitting the class of 2004 was purely on the Swedish scale ratings generated from Grade 12 results. This method was considered the only reliable predictor to determine the student's success at the university level. The study did not focus on the admission requirements as set by the university; however, more attention was paid to the admitted students' points.

The admission requirements were based on the calculation of the subject levels and admitted students were regarded as potential candidates to complete the degree within a four-year period. A minimum of 20 points was expected in order to admit the students and this was regarded as a predictor for cognitive ability to complete the degree. Furthermore, it would give the university the confidence that the right student had been selected for career opportunities. The students should be admitted with the nec-

essary credibility to graduate with the degree. To perform our analysis, we used the 89 student admission Swedish points as a predictor for university success. Figure 1 gives an indication of the admission ratings of students.

In order to be admitted for a teacher education programme, a minimum of 20 points should be obtained in the Grade 12 results. The only screening process was the Swedish ratings calculations; no interviews and psychometric test were written as part of the admission screening. In most cases, universities admit students that score the highest points in the screening process. Secondly, in order to meet this requirement, students should have subjects relating to the degree for which they wish to enroll.

From Figure 1 it is observed that a total of 17 students were admitted in 2004, and the study revealed that 14 students with Grade 12 ratings were above 50% pass in both Mathematics and Physical Sciences.

There are several possible explanations for this finding; essentially, the mismatch between high school graduation requirements and university admission requirements has been closing without forcing more students to drop out.

Graduation Output

To calculate graduation rates, the researchers used the admission Grade 12 Swedish ratings as an indicator to determine the success of teacher education. The Grade 12 ratings assist in estimating the number of students who entered a university for the first time in 2004 and dividing the resulting number into the number of students who could actually graduate with a B.Ed degree.

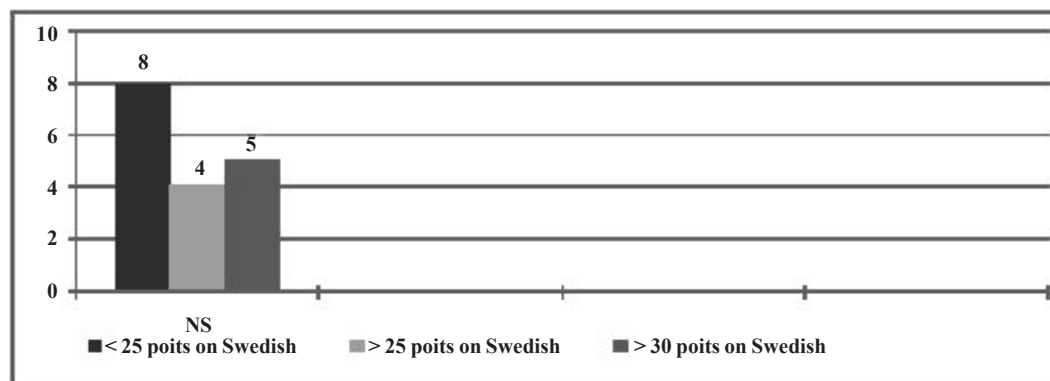


Fig. 1. Swedish Scale ratings of admitted students in B.Ed: FET in 2004

The enrolment data provided by the student administration were used to determine the number of students who entered the B.Ed: Further Education and Training Programme in 2004. This database included the total Swedish scale used by the students on enrolment counts. The intention of the research was to determine the graduation rate based on the number of students who were admitted and secondly, to gauge the Swedish scale on enrolment. The study concentrated only on students who were admitted for the first time into teacher education in the 2004 academic year. The study excluded students who were repeating their studies.

To estimate the number of students who should have graduated with the qualification at the end of the fourth year, a monitoring instrument was put in place firstly, to track first entrance students and to determine any dropouts during the course. The study revealed that there was a change in the total cohort admitted and this predicted the ultimate graduation rate. The graduating figure would have been 17 students who would have to graduate with the B.Ed: FET Specialisation at the end of the fourth year and in this case, the university would have a graduation rate of 100%. From a total of 17 students only 15 students graduated.

The study followed a cohort of students for a period of four years, from when they entered university for the first time until they graduated. While students who took longer than four years to graduate were excluded, they were not seen as possible predictors for success. Thus, as long as there was not a substantial change in the number of students in each cohort who graduated in more than four years, those students would be included as graduates in our graduation rate calculation. Table 1 shows the B.Ed graduation rates and outlines the graduation throughput per programme.

Table 1: B.Ed: Graduation rates

<i>Admitted Students in B.Ed: Natural Science</i>	<i>Graduates in B.Ed: Natural Science</i>
17 (100%)	15 (88%)

Table 1 compares the graduation rates per programme for the class of 2004 with the actual number of students who enrolled for the programme for the first time in 2004. The results of this comparison indicate that there were

not a large number of students who graduated from the B.Ed. Overall, the estimate was that more than 60% of students enrolled would graduate at the end of the fourth year, which is just under 20, the number of students who actually enrolled for teacher education at the university for the first time were 15.

Because analyses were based on the relative standing of predictors and the criteria used for admission to different programmes, possible differences in graduation statistics would be visible. Graduation rates vary considerably among the various programmes. Table 1 further outlines the different programmes and ranks the programmes on their overall graduation rates. B.Ed FET Natural Sciences specialisation has the highest graduation rate among the different programmes at 88%. These graduation rates represent students who were admitted in 2004 for the first entrance to the university and graduated in 2008 as the B.Ed programmes run over a four-year period.

These results imply that increasing the number of students who should graduate requires improving the admission requirements.

Figure 2 report on the Grade admission and the graduation rates in comparison with the admission points. From a total of 17 students who graduated, all students did pass mathematics and physical science with more 50% in the Grade 12. Although more than 17 students were admitted, only 15 managed to graduate with a degree. This pass rate was far below the school of teacher education graduate target for 2008 and much lower than the Central University of Technology graduation target. The table also shows that from the majority of students who were admitted with fewer than 25 points from Grade 12, only minority graduated. The study reveals that students who were admitted with lower ratings on the Swedish scale were much less likely to graduate with a degree in the designated time.

CONCLUSION

Children's growing understanding of basic aspects of mathematics can be observed in peer-to-peer interaction and communication. It is therefore interesting, from both research and educational practice perspectives, to observe and analyse what is being said and meant when children discuss matters that engage them.

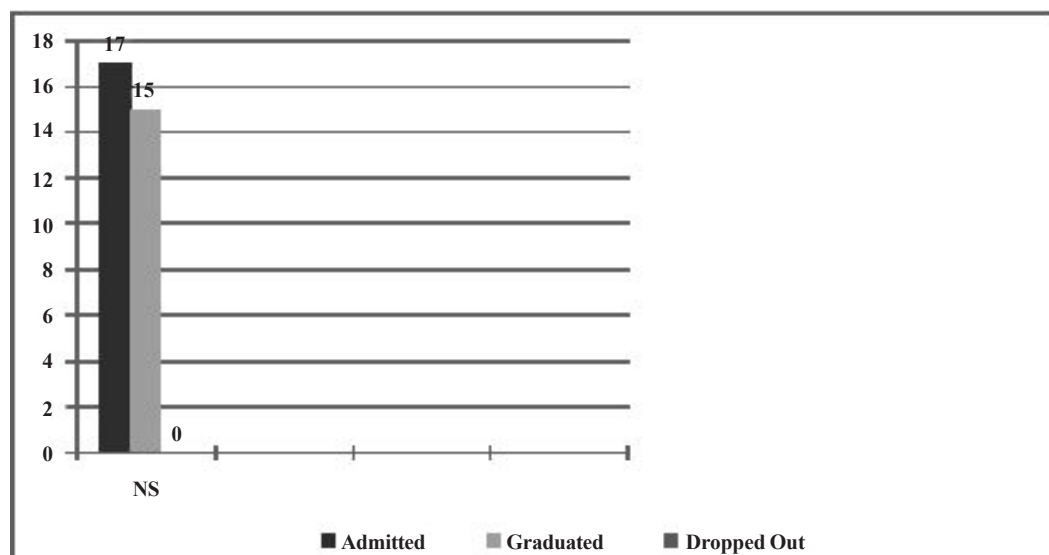


Fig. 2. Admission requirements vs graduation throughput

Children's strategies for learning as analysed and interpreted here are: 'to discern the common and specific', 'to simultaneously focus on different aspects of a phenomenon' and 'to broaden experiences'.

The findings further indicate that such low graduation rates can be attributed to the poor achievement of students in Grade 12 and it is therefore imperative that the high quintile admission be used as a predictor for university success. Students who have performed in the higher quintile in Grade 12 are likely to complete their degree in allocated time. Universities should begin to introduce support programmes in order to assist students in the lower quintile. Teacher education uses different admission procedures, based mainly on cognitive and non-cognitive criteria.

Finally, results imply that one cannot increase participation in the four-year degree without addressing the problems of high schools. The results from this study indicate that there are not a large number of students who are eligible for admission to university. This means that substantially increasing university participation in teacher education programme means increasing the number of students leaving the system with the skills necessary even to be considered for admission. Thus, reforms that focus on making university attendance less burdensome for those who already have the skills, such as in-

creased financial aid, cannot substantially increase university enrolment in themselves. Increasing university enrolment requires increasing the number of students who have the skills necessary to move on to the next academic level.

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