The predictive value of Grade 12 and university access tests results for success in higher education

by

Anneke Müller

Thesis presented in partial fulfilment of the requirements

for the degree of

Master of Education in Educational Support

in the Faculty of Education

at

Stellenbosch University

Supervisor: CHARMAINE LOUW

March 2013

By submitting this thesis electronically, I declare that the entirety of the work contained therein is my own, original work, that I am the sole author thereof (save to the extent explicitly otherwise stated), that reproduction and publication thereof by Stellenbosch University will not infringe any third party rights and that I have not previously in its entirety or in part submitted it for obtaining any qualification.

Date: 25 February 2013

Abstract

The final school examination is the gateway to higher education (HE) in most countries. Many students are however ill-prepared for HE because of a lack of quality education. Internationally, alternative access programmes are offered to address this problem. SciMathUS is the Science and Mathematics bridging programme at Stellenbosch University with the aim to allow educationally disadvantaged students whose Grade 12 results are below the standard entrance scores for admittance to HE, a second chance to improve their scores in Mathematics and Physical Sciences and then reapply for HE. SciMathUS follows a hybrid Problem-based Learning (PBL) philosophy, encouraging students to take responsibility for their own learning.

While it is expected that performance in the final school examination correlates with performance in HE, this is questioned in the case of students who do not have access to good education and, as a result thereof, leave school with poor to low results. With the high demand for HE internationally, identifying students with the potential to succeed is however a huge challenge. Alternative measurements have been and are being considered and researched. The focus of this quantitative research is to determine whether Grade 12 results (Mathematics and Physical Sciences) and Stellenbosch University Access Test (AT) results could predict success in HE for students who first attended a bridging programme. Success was defined quantitatively and measured by the results obtained at the end of their first year in HE. Quantitative techniques were used to analyse the possible relationships between the different variables.

The findings were that SciMathUS students managed to improve their Grade 12 Mathematics and Physical Sciences and AT significantly after attending the bridging programme. These results allowed them to participate in HE. No correlation could, however, be found between their NSC results or the AT results and their performance in HE. In spite of this, more than 40% of the students in this group passed their first year in HE with an average of more than 50%. Another almost 40% obtained between 30% and 50% and were therefore allowed to continue with their studies. In three faculties at Stellenbosch University, the former bridging programme students performed on par with their peers from the same schools who enrolled in HE directly after school.

Opsomming

Die finale skooleksamen bied internasionaal toegang tot hoër onderwys. As gevolg van ’n gebrek aan goeie skoolopleiding, is baie studente egter nie voldoende voorbereid vir hoër onderwysstudies nie. Om hierdie probleem aan te spreek, het alternatiewe toegangsprogramme ontstaan. SciMathUS is die Wiskunde- en Wetenskap-oorbruggingsprogram by Stellenbosch Universiteit. Die program bied aan opvoedkundig-benadeelde studente, wie se Graad 12-punte nie voldoende is om toegang tot hoër onderwys te kry nie, ’n tweede kans om hul punte in Wiskunde en Fisiese Wetenskappe te verbeter. Met hierdie nuwe uitslae kan hulle dan weer aansoek doen vir toelating. SciMathUS volg ’n hibriede probleem-gebaseerde leerbenadering wat onder meer daarop gemik is om die studente aan te moedig om self verantwoordelikheid vir hul eie leer te aanvaar.

Die verwagting is dat daar ’n korrelasie sal bestaan tussen skooluitslae en prestasie in hoër onderwys. Dit word egter bevraagteken vir studente wat nie toegang tot goeie skoolopleiding gehad het nie en as gevolg daarvan swak presteer in die finale skooleksamen. Omdat meer studente tot hoër onderwys wil toetree, raak dit toenemend belangrik om die studente met potensiaal te kan identifiseer. Alternatiewe meetinstrumente word dus geruime tyd al oorweeg en nagevors. Dit is ook die fokus van hierdie kwantitatiewe studie: om te bepaal of Graad 12 uitslae (in Wiskunde en Fisiese Wetenskappe) en die uitslae van die toegangstoetse van die Universiteit van Stellenbosch gebruik kan word om sukses van studente wat eers die SciMathUS oorbruggingskursus bygewoon het, in hoër onderwys te kan voorspel. Vir hierdie studie word sukses kwantitatief gedefinieer en gemeet aan die student se gemiddelde persentasie wat aan die einde van hul eerstejaar in hoër onderwys behaal het. Statistiese analises is gebruik om die moontlike korrelasies tussen die verskillende veranderlikes te bepaal.

Die bevindinge van hierdie studie is dat die SciMathUS-studente se Graad 12 Wiskunde en Fisiese Wetenskappe uitslae en toegangstoetsuitslae noemenswaardig verbeter het nadat hulle die program gevolg het. Hierdie uitslae het hulle toegelaat om toegang te kry tot hoër onderwys. Geen korrelasie is egter tussen die Nasionale Senior Sertifikaatuitslae of die toegangstoetsuitslae en prestasie in hoër onderwys gevind nie. Ten spyte daarvan het meer as 40% van die studente in die groep hul eerstejaar met ’n gemiddelde persentasie van meer as 50% geslaag. Ongeveer nog 40% van die studente het tussen 30% en 50% behaal en is dus toegelaat om met hul studies te kon voortgaan. In drie fakulteite by Stellenbosch Universiteit het die voormalige brugprogramstudente net so goed gevaar soos die studente wat dieselfde skole as hulle bygewoon het maar direk na skool by Stellenbosch Universiteit ingeskryf het.

Acknowledgements

I would like to acknowledge and thank the following people without whom this thesis would not have become a reality:

- Mrs Charmaine Louw, my supervisor
- Prof Kidd for his support with the statistical analyses
- My colleagues who embarked on this road with me
- My family and friends, for their support and motivation
- My parents, who have always encouraged and supported me and my brothers to study
- My two children, for putting up with a studying mother, but also for constantly challenging me to widen my horizons
- My husband and best friend, for the constructive contributions and constant encouragement
- All the SciMathUS students who inspired me to do this research, I salute you

List of acronyms

AARP	Alternative Admissions Research Project
AT	Access Test
CHE	Council on Higher Education
DoE	Department of Education
DHE	Department of Higher Education
DHET	Department of Higher Education and Training
FET	Further Education and Training
HE	Higher Education
HEI(s)	Higher Education Institution(s)
HEMIS	Higher Education Information Management System
HESA	Higher Education South Africa
HG	Higher Grade
NBT	National Benchmark Test
NNSSF	National Norms and Standards for School Funding
NSC	National Senior Certificate
NCS	National Curriculum Statement
NYDA	(South Africa's) National Youth Development Agency
OBE	Outcomes Based Education
RSA	Republic of South Africa
SA	South Africa
SC	Senior Certificate
SES	socio-economic status
SET	Science, Engineering and Technology
SFP	Science Foundation Programme
SG	Standard Grade
SU	Stellenbosch University
UCT	University of Cape Town
UK	United Kingdom
USA	United States of America

Table of contents

List of figures

List of tables

1 CHAPTER ONE

1.1 Introduction

The knowledge needed in the pre-industrial era was very different from the knowledge needed in the current so-called knowledge society and economy. Knowledge cannot be seen as something that one 'has'; it is constructed as new knowledge is needed. People need to be multi-skilled in a multidiscipline environment and be flexible in their thinking (Jarvis, Holford, & Griffin, 1998; Su, 2011). People furthermore need to be lifelong learners. Lifelong learning does not only imply the acquisition of new knowledge all the time, but also taking responsibility for one's own learning. This requires one to have the skills to do so: being self-directed, reflective and knowing how to transfer knowledge between disciplines (Merriam & Caffarella, 2007; Belanger & Tuijnman, 1997). A specific kind of education is necessary to develop these skills. This realisation has been a major motivation behind the increased influx and participation of students in higher education (HE) internationally for quite some time (Osborne & Shuttleworth, 2004; Kuh, Kinzie, Schuh, & Whitt, 2005).

A rise in the number of people entering higher education (HE) has its challenges, though. The increased participation in HE not only puts pressure on the availability of places and resources at the respective institutions (Lee, 2010), but the system is also faced with issues such as how to deal with a more diverse student population. While in earlier times attending HE was perceived as being a so-called elite activity, this has changed to a situation of mass entry (Pokorny & Pokorny, 2005; Lee, 2010). In many African countries, though, still only 5% of the 20- to 24-year-old age group attend HE (Scott I. , 2009; Taal, 2011).

Internationally, however, the finding is that many students are inadequately or unequally prepared for the demands of HE (Negash, Olusola, & Colucci, 2011; Osborne M. , 2003; Letseka, 2009). Alternative access routes to HE were consequently developed (Mabila, Malatje, Addo-Bediako, Kazini, & Mathabatha, 2006; Osborne & Shuttleworth, 2004). With the higher demand for the available places in HE, selecting students for access, and preferably selecting those who will succeed has become a highly-debated issue, internationally as well as in South Africa (Coughlan, 2006; Akoojee & Nkomo, 2007; Department of Higher Education and Training (DHET), 2012). The difference between access for participation, access for success (Akoojee & Nkomo, 2007; Coughlan, 2006) and epistemological access (Morrow, 2009) is therefore important and is discussed in more detail in Chapter Two.

The different and alternative models of student admission, selection and success have been designed and researched widely internationally but also in South Africa (Rollnick, 2010; Ross, 2010; Scott I. , 2009; Grayson, 2010; Griesel, 1999, updated 2000; Astin, 1993; Scott, Tolson, & Huang, 2010; Kuh, Kinzie, Buckley, Bridges, & Hayek, 2006). A burning issue is how to identify the potential of the students. According to Jarvis (2009), the literature

provides little concrete direction of how potential can be recognised, particularly in the case of underperforming students who have not had access to quality education in which their talents could be developed. While an argument has been that the final school examination is the best predictor of success in HE, other researchers warn that this is not always the case, especially for low-scoring students who do not have access to good education (Maree, Pretorius, & Eiselen, 2003; Griesel, 2003; Rollnick, 2010; Bothma, Botha, & Le Roux, 2004; Nel & Kistner, 2009). In South Africa, the number of learners finishing school with adequate results to enter HE is alarmingly low and the number of students who drop out of HE is alarmingly high (Letseka, 2009). The reasons why students are ill-prepared and/or dropping out are numerous. Since politics and the offering of education in South Africa are closely linked, it is necessary to discuss this issue in more detail to understand the complexity of this matter (Rollnick, 2010; Letseka, 2009).

1.2 Background to this study

My interest in access and success originates from being involved in SciMathUS, the Science and Mathematics bridging programme at Stellenbosch University (SU) in South Africa for the past 10 years where I have been responsible for the marketing of, and fundraising for, the programme. When discussing SciMathUS with funders and interested parties, I soon realised that people are not only interested in the success of the students while they attend SciMathUS. They want to know what happens to the students after they have completed SciMathUS, whether they continue their studies and how they perform in HE. The question with which SciMathUS was confronted from the very beginning was how to select candidates for the programme who are most likely to succeed in HE. Since the assessment of potential is a complex issue (Jarvis J. M., 2009)[1] or an "elusive concept" (Rollnick, 2010, p. 78) the next question the programme was confronted with was whether there are other ways to possibly predict success. These questions and my own excitement about every former SciMathUS student who graduated since 2005 motivated me to investigate the issue of the success of the SciMathUS programme and its students in more detail.

Being involved in the selection process of students for SciMathUS and having engaged with the arguments about selection, access, success and predicting success put forward in the literature made me very aware of the complexities of these issues that I was about to study. I was challenged by statements which claimed, for example, that selecting 'at risk' students into a science-orientated programme is "fraught with complexity" (Rollnick, 2010, p. 84) and that taking contextual factors into consideration to improve the efficiency of their selection "is an inexact science and relies on the extensive experience of those engaged in selection" (Rollnick, 2010, p. 84). Adding to these is the debate in the literature whether final school

[1] The MS Word referencing system was used in this thesis. MS Word adds the initials of authors with the same surnames to differentiate between them when cited in the text.

results are reliable predictors of success. The research I was about to undertake was to determine whether Grade 12[2] results (Mathematics and Physical Sciences) and university access test (AT)[3] results could predict success in HE for students who first attended a bridging programme. The argument in the literature by authors such as Altink (1989), Griesel (1999, and updated in 2000), Zaaiman, Van Der Flier and Thijs (2000), Naumann, Bandalos and Gutkin (2003), Koch (2007), Nel and Kistner (2009) and Rollnick (2010) is that Grade 12 results are not a reliable predictor of success in HE for low-scoring students, the group of students whose success I was about to investigate. The question was, whether the students' improved National Senior Certificate (NSC) results in Mathematics and Physical Sciences, (if they improved?) after attending the SciMathUS bridging programme would predict success in HE.

SciMathUS is a year-long bridging programme at Stellenbosch University that offers students from educationally disadvantaged circumstances, who do not meet the entry requirements to be admitted into HE, a second chance to qualify to do so. The programme allows students to choose between Mathematics and Physical Sciences or Mathematics and Accountancy. Initially students rewrote the NSC examinations in all three these core subjects. A few years ago the Accounting curriculum changed, and now Introduction to Financial Accounting and Introduction to Economics are offered and assessed by the Faculty of Economics and Management Sciences at Stellenbosch University. Students still rewrite the NSC examination in Mathematics and Physical Sciences, as students in South Africa need to meet basic entry requirements for admission into HE[4].

Although the curriculum is based mainly on Grade 12 work, a hybrid problem-based learning (PBL) philosophy of teaching and learning is followed in SciMathUS (Smit, 2011; Malan, 2008). Instead of focusing on the teaching offered by teachers, the focus in the programme is on the learning of the students. Students are also taught skills on how to think more critically, how to study effectively and how to take responsibility for their own learning. Content is studied thematically and therefore students sometimes have to go 'back to basics' (prior to Grade 12) to fully understand a specific concept (Smit, 2011). For the past 11 years the students have improved their results in each of the core subjects by an average of more than 15 percentage points. A number of students managed to improve their results by more than 50 percentage points. The question was: does this mean that they will be successful in HE?

---

[2] NSC and Grade 12 examinations are used in South Africa as synonyms. They both refer to the final school examination.

[3] Stellenbosch University in this case.

[4] The minimum admission requirements for a Bachelor's degree in South Africa at the time of this study is a National Senior Certificate (NSC), as certified by Umalusi, with a minimum of 30% in the language of learning and teaching of the higher education institution concerned, in addition to an achievement rating of 4 (adequate achievement, 50%–59%) or better in four subjects chosen from a designated subject list (Umalusi, 2010, p. 27).

Engaging with the literature also made me realise that success is not a matter that can be analysed statistically (quantitatively) only. Even though the study in itself investigates whether there are correlations between Grade 12 results, results obtained in this specific AT and the results obtained by students at the end of their first year, there cannot be only one criterion to determine success and a quantitative approach is not sufficient to do so. The different viewpoints about access and success put forward by authors such as Astin (1993), Tinto (2006-2007), Kuh *et al.* (2005 & 2006) as well as Pascarella and Terenzini (2005), as well as the influence of individual and contextual factors on success, are a field of study in its own right. These arguments made me realise that this study can only be part of a bigger investigation that has to be undertaken if justice is to be done to the students on their journey to success. Although one usually comes to such as conclusion at the end of a study, I realised this fairly soon after I started this investigation. The first step, therefore, was to determine how the students performed after attending the programme and how they performed in HE. This first quantitative investigation is necessary before the reasons for the success or failure of the students can be investigated. I explain this in more detail in Chapters Two and Three.

The influence of the political situation on education in South Africa over many years is something else to be taken into consideration. As indicated above, the influx of students in HE in this country is also linked to the need to redress of the wrongs of the past. The Republic of South Africa (RSA) appointed its fifth post-apartheid Minister of Education in 2011. The Department of Education was also split into two in 2011 and a minister for Basic Education and one for Higher Education were appointed. Each minister announced influential and far-reaching policy changes and revisions. The reasons why students are ill-prepared and/or dropping out are numerous. It is not within the scope of this study to discuss these, but they cannot be ignored either.

Just as the reasons for limited participation in HE vary, so do the reasons for access programmes vary between countries and also between what kinds of programmes are offered. I chose to follow Lee's (2010) categorisation of pre-entry, entry and post-entry programmes, but also acknowledging that there is an overlap between the categories and programmes. In the end all access interventions require students to invest additional effort or more time to be successful (Rollnick, 2010).

Pre-entry programmes are defined as programmes offered mostly to students before they enter HE and often before they have written the exit examination of the phase prior to entering HE. These programmes are aimed at raising the awareness, aspirations and attainments of school pupils to encourage them to consider HE (often a specific higher education institution (HEI)) and to provide them with the necessary support to achieve this objective (Lee, 2010). There are several school intervention programmes in the USA and in South Africa. Summer camps and summer schools are also popular in the USA (Rollnick, 2010).

Entry or access programmes take students one step closer to entering HE (Lee, 2010). In some cases students may have written the exit examination of the previous phase, but have not necessarily passed the examination with results good enough to be allowed into HE. In some of the programmes, such as SciMathUS, the programme investigated in this study, students are offered the opportunity to re-write some components or the whole of the exit examination, or in some cases no examination is required (Smit, 2011). These programmes usually offer a structured admission process for students who successfully complete the programme if no formal examination is written (Lee, 2010).

The distinction between entry and post-entry programmes is also not always particularly clear, as indicated above. While some foundation programmes offer the first modules of a degree programme, they can either be classified as entry or post-entry. Post-entry programmes also vary in what they have to offer. Some create a welcoming and stimulating environment for learning, while others provide support through short workshops, specific skills training, tutoring, mentoring or counselling, aimed at ensuring that students stay on course and complete their studies successfully (Lee, 2010). The programmes are offered internationally by many higher education institutions. Some of these programmes are accredited and certificates of competence or attendance can be obtained by the participants (Stellenbosch University, 2012).

Since SciMathUS is an example of a programme to gain entrance to HE, I studied the literature about access programmes internationally. I realised that SciMathUS was not mentioned in research published as recent as 2010. This study is therefore also an attempt to make available information about a successful bridging programme in South Africa. By doing so, I would like to participate in the debate about access and make a contribution to the research on access programmes. I do want to state, however, that the aim of this study was not to evaluate the success of the programme as such. The curriculum and how it is presented the teaching philosophy, were not discussed and evaluated.

Access programmes are studied for various reasons. While some research is aimed at evaluating the value of access programmes (Akoojee & Nkomo, 2007), others compare the performance of students from specific (access or advanced) programmes with students who did not participate in these programmes (Scott, Tolson, & Huang, 2010; Fernando, Prescott, Cleland, Greaves, & McKenzie, 2009). Some of the research focuses on student selection (Trapmann, Hell, Hirn, & Schuler, 2007) and some seek to develop a framework for selection (Eiselen, Strauss, & Jonck, 2007), or a framework for the placement of university students in specific programmes (Jacobs, 2010). Another focus is to develop or test an assessment tool for predicting first-year student achievement and progression (Lowis & Castley, 2008; Downs, 2005; Dursan, 2012) or success in HE in general (Naumann, Bandalos, & Gutkin, 2003; Ramrathan, Manik, & Pillay, 2007). Some focus their research on the level of

preparedness of students for specific programmes (Scott, Tolson, & Huang, 2011), while others focus on student retention (Lowis & Castley, 2008; Kennet & Reed, 2009).

The arguments about access and success put forward by the multitude of research studies on these topics made me very aware of the complexity of the issue. Most commonly, student success is measured and determined quantitatively by pass and retention rates (Gibbon, 2009; Akoojee & Nkomo, 2007; CHE, 2006; Kuh, Kinzie, Buckley, Bridges, & Hayek, 2006). Even though the study in itself investigates student success by looking at pass rates, only a number does not do justice to the issue of student success. Student success cannot be defined by meeting academic goals only. There are more criteria to determine success.

According to Tinto, the study of student attrition (and by implication students' being successful or unsuccessful) is easily one of the most widely investigated topics in HE the past 30 years (Tinto & Pusser, 2006). According to Kuh, Kinzie, Schuh and Whitt (2005), as well as Pascarella and Terenzini (2005) and Astin (1993), the amount of time and energy students put into their studies and other activities is a better predictor of success than what they learn. Morrow (2009) argues that success is only achieved after the learner has become a successful participant in an academic practice. These and other viewpoints are also discussed in more detail in Chapter Two.

Success and performance (and the lack thereof) cannot be discussed without acknowledging the factors that influence them. According to a Council on Higher Education (CHE) study (2006), there are three approaches to studying factors that have an influence on academic achievement, performance or success. The first approach describes academic performance on the basis of individual attributes of the student. The second approach offers explanations for student performance in social and cultural processes within the institution. The third is the more traditional statistical approach as it measures student success in terms of a set of quantitative indicators. This three-pronged approach as well as the development theories of Astin (1993) and Tinto (2006), Tinto and Pusser (2006) as well as Pascarella and Terenzini (2005) inform the discussion of these factors in Chapter Two.

1.3 Research question

The research question of this study was to determine whether Grade 12 results and AT results could predict success in HE for students who first attended a bridging programme. It can be expected that there would be a positive correlation between final school results as an example of an achievement test and success in HE, because the assumption is "that a student needs to have some mastery of knowledge and skills offered in previous education to be able to profit from subsequent education" (Altink, 1987, p. 2). However, if the quality of schooling varies considerably (as in South Africa), the use of Grade 12 results for the purpose of selection, evaluation or prediction of success is questioned. The assumption is therefore that, if the

students attending SciMathUS manage to increase their scores in the core subjects (Mathematics and Physical Sciences) to a level which allows them to gain access into HE, their new improved Grade 12 results will yield a positive correlation with their performance in HE.

In this study the NSC Grade 12 results in Mathematics and Physical Sciences obtained by four different year groups (2008-2011) of students prior to entering SciMathUS were compared to the sets of the NSC Grade 12 results in these same subjects obtained by these same students after completing the SciMathUS programme one year later. Two sets of Stellenbosch University AT results obtained by three different year groups (2009-2011) students were also compared. One set of AT was written within the first days after entering the bridging programme and another set written towards the end of the programme. These two sets of results (NSC and AT) were also compared with one another to determine a possible relation between them. Lastly, these two sets of results were used (independently) to determine whether there is a relation between these results and the results obtained by the students at the end of their first year of study in HE. This was done in an attempt to identify whether these results could possibly predict the success of these students in HE. In the quantitative investigation, the following analyses were conducted.

To analyse the differences in performance prior to and after the intervention:

- the difference between the pre- and post-SciMathUS intervention in Mathematics and Physical Sciences was determined; and
- the difference between the pre- and post-SciMathUS intervention in the AT Mathematics and Physical Sciences was determined.

To analyse whether there is a relation between NSC and Access test results:

- the relation between NSC Mathematics results and AT results in the sub-test Mathematics was determined; and
- the relation between NSC Physical Sciences results and AT results in the sub-test Physical Sciences was determined.

The following analyses were done to determine whether there was a relation between Mathematics and Physical Sciences NSC results of the SciMathUS students and their results at the end of the first year in HE:

- analysis of the relation between pre-SciMathUS results in Mathematics and first-year average; and

- analysis of the relation between post-SciMathUS results in Physical Sciences and first-year average

The following analysis was done to determine whether there was a relation between NSC results and HE results at the end of the first year in comparison to other students:

- analysis of the relation between the average of SciMathUS students and students who attended the same schools in six faculties in HE, but who did not attend SciMathUS.

These issues were investigated through quantitative analyses and are discussed in more detail in Chapter Four.

1.4 Research paradigm

A research paradigm refers to the accepted tradition or framework that guides all aspects of research; its laws, beliefs, procedures, methods, the analysis and the interpretation of the data collected (Creswell, 2009; Gorard & Taylor, 2004; Babbie & Mouton, 2011; Mertens, 2005). The research question of this study was to determine whether Grade 12 results and AT results can predict success in HE for students attending a bridging programme first. This question required a statistical analysis of the former SciMathUS students' performance. This study is therefore a quantitative study.

This study is the first attempt to analyse the performance of the SciMathUS students as a group in HE and therefore a very necessary study. Only once the performance of the students is known, can one qualitatively analyse the reasons for their success and/or failure. This study can therefore only be seen as the first step towards analysing the success of the students. It is therefore also necessary to acknowledge that, although quantitative, this study is also embedded in a rounded view of research as comprising quantitative and qualitative components. The argument against the strict distinction between quantitative and qualitative research is therefore also presented in Chapter Three.

1.5 Research design and methodology

Quantitative methods involve the process of collecting, analysing, interpreting and discussing the results of a study (Claxton, 1990). As the present study used data that already exist (students' results), it can be classified as an empirical study making use of secondary numerical data as described by Babbie and Mouton (2011).

1.5.1 Selection of participants and selection criteria

The 'participants' in this study are represented by their results only. The results that were analysed in this study can be divided into two sets: (i) the pre-HE results of students who attended SciMathUS from 2008-2011: National Senior Certificate or Grade 12 Mathematics and Physical Sciences results as well as Stellenbosch University Access Test (AT) results and (ii) the HE results obtained by students at Stellenbosch University (SU) at the end of their first year of study in 2009, 2010 and 2011.

In SciMathUS students have a choice between two streams: Science and Mathematics, and Accounting and Mathematics. Students who choose the Science stream rewrite both the Physical Sciences and Mathematics examinations of the NSC at the end of the bridging year. Those enrolled in the Accounting stream rewrite only the Mathematics NSC examination. The Faculty of Economic and Management Sciences at Stellenbosch University offers the Introduction to Financial Accounting and Introduction to Economics courses and assesses the students in these courses. As described in section 2.6 of Chapter Two, the Accounting curriculum in SciMathUS is offered and assessed by Stellenbosch University. The pre- and post-intervention results are obtained by different examinations and can therefore not be compared. In terms of pre- and post-intervention results, only Mathematics and Physical Sciences results were used in this study.

The NSC Mathematics and Physical Sciences results as well as the AT results were obtained from the programme itself, whereas the first-year results of all these students were obtained from Stellenbosch University, the HEI where these students enrolled. The entry requirements for SciMathUS as well as the different sets of data used for the different analyses are described in more detail in Chapter Three, section 3.4.1.

1.5.2 Data-collection instruments and methods

Data were gathered from SciMathUS, the bridging programme itself and from SU, the HE institution where the students enrolled. Different configurations of results were used for different analyses. This process is described in detail in section 1.3 of this chapter as well as in Chapter Three, section 3.4.2. Below is a summary of the data that were collected:

- two sets for NSC examination results in Mathematics and Physical Sciences of the students (prior to and after the intervention), obtained from SciMathUS;
- two sets of AT results for all the students, also prior to and after the intervention, obtained from SciMathUS; and
- one set of results of the students who enrolled at Stellenbosch University at the end of their first year in HE, obtained from Stellenbosch University.

1.5.3 Data analysis

For the comparison of the pre- and post-intervention analyses, a mixed model repeated measures ANOVA was conducted with time (pre and post), year as fixed effects and the students as random effect. The time-year interaction effect was tested as part of this analysis which tested whether the change in results from prior to the intervention to after the intervention were the same for all the years (2008-2011), indicated in this study. Relationships between different sets of results were tested, using Pearson correlations. In the comparisons of SciMathUS students with their peers from the same schools and enrolled in the same faculties, a two-way ANOVA with group and faculty as the two factors were done. As in the previous comparison, the group and faculty interaction effect tested whether the difference in results between SciMathUS and their peers were the same in all the faculties. From a post-positivist perspective, statistical analysis is an attempt to be as accurate as possible to get to the reality, according to Lincoln, Lynham and Guba (2011). The findings will be discussed in Chapter Four.

1.5.4 Data verification

Reliability and validity are central issues in quantitative measurements. Researchers want their research to be credible and therefore should the measures be valued as reliable and valid. In this study, tests scores were valid constructs to measure the performance of students. If the same analysis were to be repeated with the same instruments (Anastasi & Urbina, 1997; Neuman, 2000), using the same scores of the same students, the same results will be revealed, indicating that the results of this study are reliable.

1.6 Ethical considerations

Ethics is a philosophy of morals, a moral system that defines duty, prescribes behaviour and labels conduct as right of wrong, better or worse. Ethics rests upon moral integrity (Glass, 1965; Resnik, 1998). Science depends upon a scientist's integrity. Glass (1965, p. 1255) notes that "[t]he loss of scientific integrity through deliberate charlatanry is less common than the violation of scholarly honesty though plagiarism". All research should be conducted within clearly defined ethical principles to ensure the protection of the participants and the researchers.

It is necessary to distinguish between ethics and other social norms such as laws. Lying, for instance, is perceived as unethical, but it is not illegal. Ethical conduct in science, however, should not violate commonly accepted moral standards and it should promote the advancement of scientific goals (Resnik, 1998). Glass (1965) proposes four commandments or principles as the ethical basis of science: to be completely truthful; never to steal anyone's ideas; to defend scientific freedom and inquiry fearlessly, because science cannot prosper

where daring thinking is inhibited; and to fully communicate one's findings through primary publication, synthesis and instruction. This is elaborated on in Chapter Three, section 3.7.

To ensure that the ethical criteria were satisfied, approval for this study was obtained from the Research Ethics Committee: Human Research (Humanities) at Stellenbosch University on 26 April 2012. The protocol number of this approval is HS794/2012. The Senior Director, Institutional Research and Planning also approved the request to use the data for this investigation. The director of the Institute for Mathematics and Science Teaching at Stellenbosch University, where SciMathUS is housed, approved the use of the SciMathUS data. Copies of the approval documents are attached (See attachments 1, 2 & 3) All data were treated with the utmost confidentiality.

1.7 Key terms

Higher Education

Higher education (HE) is understood as including "all types of studies, training, or training for research at the post-secondary level, provided by universities or other educational establishments that are approved as institutions of HE by the competent State authorities" (UNESCO, 1998).

Access

Access is defined differently by different countries (Lee, 2010). 'Access' generally means access to HE, but sometimes it also means access to study particular study programmes. In this study access is defined in three ways:

- access for participation indicates enrolment in HE (Rollnick, 2010);
- access for success indicates that the students who enrol pass their modules and ultimately graduate (The European University Association, 2010; Akoojee & Nkomo, 2007); and
- epistemological access is about learning how to become a participant in academic practice as defined by Morrow (2009).

Widening access

Like access, widening access is also interpreted differently in different countries. Different HEIs also have different criteria that students have to meet to gain access to these alternative access routes. The term in general means increasing the representation in HE of students from under-represented groups. While many countries refer to low socio-economic groups when they refer to under-represented groups, some also explicitly include people with disabilities

(Lee, 2010). In this study it is defined as allowing students who do not meet the entry requirements for HE an alternative way to gain access to enter HE.

Success

There are multiple definitions of the concept of success. Most commonly student success is measured and determined quantitatively by pass and retention rates (Akoojee & Nkomo, 2007; Council for Higher Education, 2006; Kuh, Kinzie, Buckley, Bridges, & Hayek, 2006; Gibbon, 2009). For the sake of this study, success is defined quantitatively and determined by pass rates at the end of the first year.

Predictive validity

Predictive validity is defined as the extent to which a measure accurately forecasts how a person will think, act or feel in the future (Visser & Hanslo, 2005). High predictive validity means a strong relationship with previous scholastic performance (Altink, 1987). In a university context it refers to the extent to which predictions can be made about the future academic potential of students using scores on testing instruments selecting particular constructs (Visser & Hanslo, 2005).

1.8 Overview of chapters

Chapter Two discusses the themes identified as important for this study. These themes include societal changes and how they have an impact on the kind of knowledge needed and, as a consequence, on education. The development of education and HE in South Africa is briefly discussed as this is the context in which this investigation is conducted. This is followed by a discussion about the difference between access for participation, access for success and epistemological access. In the deliberation about widening access, structures to allow widened access internationally are also mentioned. A discussion on success and factors impacting on success conclude Chapter Two.

In Chapter Three the research design and methodology are contextualized with reference to the research problem and objectives. Chapter Four reports on the results of the empirical investigation and collection of data, use of statistical concepts as well as on procedures and analyses. The analyses were done to determine whether there are relations between different selected variables and whether these variables can be used to predict success in HE. The statistical correlations and predictability of Grade 12 results, AT results and achievement at the end of the first year in HE are discussed.

Chapter Five presents the final discussions, conclusions, strengths and limitations of this study. As indicated earlier, this study should be seen as only a first attempt to do justice to the

argument of access for success, particularly for this group of students. The limitations of the study and recommendations for future research are presented and conclude this investigation.

The references follow Chapter Five.

2 CHAPTER TWO

2.1 Introduction

Education in general, but the higher education (HE) sector specifically, experiences constant change internationally and in South Africa. The first aim of this chapter is to briefly reflect on issues that have an impact on the development of education and how this leads to more people entering HE.

The Industrial Revolution, which started in the middle of the eighteenth century, marks a major turning point in almost every aspect of daily life and therefore also in education. More recently, the development of the knowledge economy and the explosion of innovations in the field of technology have also had an influence on education and the kind of education people need. The knowledge needed by this 'new' workforce and society has changed and is changing constantly as new knowledge is needed. Knowledge cannot be seen as something that one 'has'. Knowledge is constructed. People need to be lifelong learners, knowing how to make sense of knowledge (Su, 2011), how to be multi-skilled in a multidiscipline environment, how to adjust to change, think for themselves and be flexible in their thinking (Jarvis, Holford, & Griffin, 1998; Su, 2011). In this knowledge economy there is a need to compete effectively and to sustain future economic development. This is a big driving force behind increasing participation and the influx of students into HE (Osborne & Shuttleworth, 2004; Kuh, Kinzie, Schuh, & Whitt, 2005).

Over many years many different models of student admission and selection have been widely researched internationally (Belanger & Tuijnman, 1997; Cliffordson, 2008; Pascarella & Terenzini, 2005; Tinto & Pusser, 2006) and in South Africa (Maree, Pretorius, & Eiselen, 2003; Scott I. , 2009; Rollnick, 2010; Scott, Yeld, & Hendry, 2007; Bothma, Botha, & Le Roux, 2004). In the American system students are being prepared for HE on different levels at school and after. In many programmes, students study generic and often basic programmes at so-called community colleges. "Joining in" (Kuh, Kinzie, Schuh, & Whitt, 2005, p. 111) and appropriate placement of students on undergraduate as well as on postgraduate level are also researched and reported on widely (Coughlan, 2006; Jacobs, 2010; Nel & Kistner, 2009; Zaaiman, Van Der Flier, & Thijs, 2000; Enslin, Button, Chakane, de Groot, & Dison, 2006). In some instances this 'joining in' process starts long before the student actually joins the institution, such as when prospective students visit the higher education institution "to imagine what being a student would be like" (Briggs, Clark, & Hall, 2012, p. 6). While some programmes prepare students only for participation in HE, others aim for access for success. The specific programme under investigation, SciMathUS, is introduced against the background of this distinction.

The following section of this research focuses on the different access programmes as they are discussed in the literature. The research on access programmes and related issues can be categorised as follows:

Research on:

- evaluating the value of access programmes (Akoojee & Nkomo, 2007);
- comparing the performance of students from specific (access or advanced) programmes with that of students who did not participate in these programmes (Scott, Tolson, & Huang, 2010; Fernando, Prescott, Cleland, Greaves, & McKenzie, 2009);
- student selection (Trapmann, Hell, Hirn, & Schuler, 2007);
- developing a framework for the placement of university students in specific programmes (Jacobs, 2010);
- developing an assessment tool for predicting first-year student achievement and progression (Lowis & Castley, 2008; Downs, 2005; Dursan, 2012) or success in HE in general (Naumann, Bandalos, & Gutkin, 2003; Ramrathan, Manik, & Pillay, 2007);
- the level of preparedness of students for specific programmes. This research varies from what is needed for a student to be successful in HE (Kuh, Kinzie, Schuh, & Whitt, 2005; Scott, Tolson, & Huang, 2011) to student retention (Pascarella & Terenzini, 2005). The selection of students and the grounds on which they are selected also interested a number of researchers.

Since the ultimate aim for access into HE is for students to be successful, the concept of success is of importance for this study. There are multiple definitions of the construct ‘success’. Most commonly student success is measured and determined quantitatively by pass and retention rates (Gibbon, 2009; Akoojee & Nkomo, 2007; Council on Higher Education (CHE), 2010). Authors such as Astin (1993), Tinto (2006), Kuh, Kinzie, Schuh and Whitt (2005), Pascarella and Terenzini (2005) and Morrow (2009) argue differently. These and other arguments are introduced in more detail in this chapter.

Success and performance and the lack thereof cannot be discussed without taking the factors that influence them into consideration. This will be done in the last section of this chapter. The approach proposed by the Council on Higher Education (CHE) (2006) and the different theories on student development put forward by a number of researchers are used in discussing these factors in this study. Factors influencing student success are clustered around individual attributes of the student as well as around social and cultural processes within the institution. The third and more traditional statistical approach was also applied and is reported on in Chapter Four.

2.2 The development of education in South Africa

2.2.1 A brief overview of the development of higher education in South Africa before 1994

This section does not attempt to provide a critical overview of the education system in South Africa. The aim is to merely give a very brief outline of the historical origins of South Africa's higher education system. It is also essential to understand why there is a need for widened access in this country and why a programme like SciMathUS exists and is (still) necessary.

The origins of the South African university system can be traced back to the establishment of the South African College in Cape Town in 1829. In 1873 the University Incorporation Act was passed by the then Cape government and the University of the Cape of Good Hope became the first university in South Africa. This university was modelled on the London University and was the only examining and degree-granting body in the country. It offered a range of degrees including Law, Arts, Divinity and Agriculture, and certificates in civil engineering, music and other courses, as well as for the other colleges such as Victoria College in Stellenbosch, Natal University College, Grey College in Bloemfontein, the University of South Africa and the Transvaal University College in Pretoria, institutions that were established later. Another precondition for students to obtain a degree was that they had to have a good comprehension of English (Maharajh, Motala, & Scerri, 2011; Reddy T. , 2004; Council on Higher Education, 2004).

As in the rest of the world, the skills requirements of the country made it imperative for the HE sector to develop. Rapid industrialisation between the two World Wars provided a strong stimulus for the accelerated development of the HE sector. The growth of the HE sector in South Africa was greatly tied to the development of two primary sectors. The one was mining, after the discovery of gold and subsequent developments around that. The other one was agriculture (Maharajh, Motala, & Scerri, 2011).

South Africa had a well-established education system for white people between 1948 and 1994 (Reddy T. , 2004), while education for black people (the term is used here in a generic sense) was perhaps one of the most acute examples of systemic and social exclusion. After the National Party came into power in South Africa in 1948 – ironically the same year that the United Nations adopted and proclaimed the Universal Declaration of Human Rights – its policy of segregation inevitably also shaped the education system of the country. People were discriminated against not only in terms of race, but also through government policy and legislation. Amongst other things, there were eventually 17 departments of education (Naicker, 1999) in the country. Furthermore, the apartheid government spent far less money on the education of black learners than on whites. Even as late as in 1993, only one year prior

to the transition from apartheid to democracy, the average amount spent by the government on the education of every white learner was nearly three times more than that spent on a black learner: R4 504 compared to R1 532 (Osborne M. , 2003).

After 1948 black people were not allowed at any so-called 'white universities'. At the time of the Eiselen Commission on Native Education in 1951, there was only one residential university for black Africans, the South African Native College at Fort Hare, with an enrolment of only 343 students. More than a quarter of the total student population enrolled at the then only distance-education institution, the University of South Africa (UNISA), were black students (Akoojee & Nkomo, 2007). The National Party government eventually established universities for all but three of the ethnic (black) groups in the rural areas, the so-called homelands. They also even put legal constraints in place to prevent institutions from enrolling students from other racial groups. This led to the 1959 Extension of University Education Act, which in effect barred black students from attending 'white universities'. In 1984 this Act was relaxed. Black students were allowed to enrol at 'white institutions' only when courses were not offered by 'black institutions', and then only with the written permission of the Minister in each case (Akoojee & Nkomo, 2007). The first medical school for 'non-whites' was established at the University of Natal in 1950 (Maharajh, Motala, & Scerri, 2011; Reddy T. , 2004; Council on Higher Education, 2004).

By 1988 eleven HE institutions for whites had been established in South Africa. The Minister of Education and Training administered all education for African black people. The management of coloured and Indian education changed several times between 1910 and 1983. In terms of the 1983 Constitution all coloured education became the responsibility of the Minister of Education and Culture, Administration: House of Representatives, while all Indian education was the responsibility of the then Minister of Education and Culture, Administration: House of Delegates. In the case of whites, prior to September 1984, provincial departments managed and provided all basic education but what was defined by law as higher education (technical colleges, technikons and universities), was the responsibility of the then Department of National Education. Provincial education departments became sub-departments of the Department of Education and Culture, Administration: House of Assembly and higher education became the responsibility of this Minister.

In 1992 the undergraduate headcount enrolments at the seven historically 'black universities' were concentrated in the fields of Arts and Social Sciences (45%), Education (19%), Economic Sciences (15%) and Law (11%). A small number of students were enrolled in the Natural Sciences (5%), Health Sciences (4%) and Agriculture (1%) (Education Policy Unit, 1997, p. 97). Although the white population was one of the minority population groups, they

had access to six Afrikaans-medium universities, four English-medium universities and one dual-medium university (Council on Higher Education, 2004).

2.2.2 Education in post-1994 South Africa

The newly elected government of 1994 was committed to developing a country that respects and values diversity and provides equal opportunities for all. All 17 education departments were unified. In 1994 there were 21 public universities, 15 public technikons, 120 colleges of education, 24 nursing colleges and 11 agricultural colleges in South Africa. During 2001 all the colleges of education were incorporated into universities and technikons. Smaller universities and technikons (polytechnics) were incorporated into larger institutions to form comprehensive universities. The six so-called comprehensive universities in South Africa offer a combination of academic and vocational diplomas and degrees, while the six universities of technology focus on vocationally oriented education. The 11 traditional universities offer theoretically oriented university degrees (www.southafrica.info, 2012; Department of Education, 2004). There are currently 99 private higher education institutions registered in South Africa (Higher Education South Africa (HESA), 2011; Council on Higher Education, 2004).

On 10 December 1996, exactly 48 years to the day after the General Assembly of the United Nations adopted and proclaimed the Universal Declaration of Human Rights in 1948, President Nelson Mandela promulgated the Bill of Human Rights of the South African Constitution. When it came into effect on 4 February 1997 it recognised, amongst other things, education as a basic human right of every citizen in South Africa (Republic of South Africa (RSA), 1996). The National Department of Education (DoE) released the first Education White Paper in 1995. The aim was not only to build a more equal society in comparison to the pre-1994 dispensation, but also a unified and fair education system for all. It aims to create schools that are responsive to learner diversity and to provide equal educational opportunities for all. This renewal process continues to this day.

In 2009, Parliament approved the statutory minimum entry requirements to higher education requiring a National Senior Certificate, in terms of section 74 of the Higher Education Act, (Act No. 101 of 1997) (Department of Education, 2005 (revised in 2008)). Also in 2009, the Department of Education (DoE) was divided into two separate ministries: the Department of Basic Education (DBE) and the Department of Higher Education and Training (DHET). This department is to re-open three former teacher training colleges in 2013. The motivation for this is that South Africa needs more and better teachers (www.southafrica.info, 2012). Early in 2012 the Minister of the Department of Higher Education released a Green Paper for Post-School Education and Training (Department of Higher Education and Training (DHET), 2012). The discussion about education and education policy continues.

2.3 What is higher education?

Higher education (HE) was defined as "all types of studies, training, or training for research at the post-secondary level, provided by universities or other educational establishments that are approved as institutions of HE by the competent State authorities" at the UNESCO World Conference on Higher Education in 1998 (UNESCO, 1995-2012). The role of HE has become increasingly more important because society has become progressively information and knowledge based. To enable the realisation of all its potential benefits, HE needs to be cultivated, nurtured and supported both in terms of creating a conductive policy environment and committing the right resources to deal with the complexities of issues such as access and massification, the brain drain, staff and student retention and infrastructure (Jarvis, Holford, & Griffin, 1998; Negash, Olusola, & Colucci, 2011; Letseka, 2009).

2.4 Access to HE

While underlining the need for global unity and cooperation to promote HE in an increasingly globalised setting, the 2009 World Conference on Higher Education emphasised the need to promote HE in especially Africa to develop the continent (UNESCO, 1995-2012). Tertiary education is often considered as less important compared to primary and secondary schooling from an economic point of view (i.e., greater return on investment) and equity considerations. Although this is true to a certain degree, it is also true that a HE qualification can help Africa (everyone for that matter) raise their level of productivity, not only to help oneself, but also to compete internationally (Negash, Olusola, & Colucci, 2011). There is a warning, however, that HE should not try to be everything to everybody and try to create the means for everyone to escape from poverty. Access to HE should be granted selectively only to those who are sufficiently motivated, and sufficiently capable, or those whose expectations of HE are correct and realistic. Institutions that grant students access because students feel that they are entitled to such access, may run the risk of sacrificing their academic obligations (Coughlan, 2006; Morrow, 2009). Astin describes the purpose of higher education as one of "talent development" (Pascarella & Terenzini, 2005, p. 53).

2.4.1 Access for participation, access for success and epistemological access

Access programmes are viewed from different perspectives and are given different names by different HE institutions. Some programmes are called 'access for participation programmes'. Success is indicated by enrolment in HE, like in the UK (Rollnick, 2010). 'Access for success' programmes measure success by the number of students who graduate (The European University Association, 2010; Akoojee & Nkomo, 2007; Rollnick, 2010). According to Rollnick (2010), little data was available about the success rates of access programmes (in the UK), especially about the success of ethnic minority groups in spite of the

programmes being in operation for a number of years and in spite of the fact that the programmes were initially designed for these groups.

Looking at access from an enrolment (participation) or graduation (success) viewpoint is in a sense a formalistic way of looking at access. Both enrolment and graduation rates can be measured and that is what institutions do and should do. Enrolment and graduation therefore also need to be managed by the institutions. This also implies that institutions should be responsible for whom they allow as students and they should therefore be selecting the correct students. Institutions should also make sure that they put structures in place so that students leave with an academic qualification or a certificate (Tinto & Pusser, 2006; Schwartz, 2004).

Morrow (1994) distinguishes between formal access and epistemological access. To Morrow formal access means the ability to gain entrance to a programme while epistemological access concerns learning how to become a participant in academic practice. What Morrow (2009, p. 78) makes us understand is that "access is essentially dependent on what *I do"* (emphasis in original) once "I" have been granted access to an institution. A learner[5] should want to learn how to become "a successful participant in an academic practice". The learner is an active agent in his or her own epistemological access and should actively participate in an educational experience which should be life-changing. This is in line with the social-constructivist theory which argues that knowledge is actively constructed and not merely passively received (Kugelmass, 2006). This does not imply that the learner should "invent knowledge" or be responsible for the design of his or her own curricula. The learner should, however, take responsibility for his or her own *learning* (my italics). This is also what SciMathUS strives to achieve in their PBL approach to teaching and learning (Smit, 2011; Malan, 2008).

2.4.1.1 Access from an economic perspective

The massification of HE is necessary from a democratisation and human rights point of view, not only in providing equal rights for all citizens, but also from an economic point of view. Higher education is a valuable commodity: it affects salary, job security and power to influence society (Schwartz, 2004). In research undertaken by UNESCO, the authors argue that there is a clear correlation between the level of participation in higher education and economic development in the world. The participation rate in the United States is more than 70%. In the fourteen countries[6] that are part of the Organisation for Economic Co-operation

[5] Morrow uses the term learner as his concept implies a learning process. The term student is used throughout this study when referring to people attending Higher Education Institutions whereas the term learner refers to youngsters attending school.

[6] Australia; Austria; Belgium; Canada; Chile; Czech Republic; Denmark; Estonia; Finland; France; Germany; Greece; Hungary; Iceland; Ireland; Israel; Italy; Japan; Korea; Luxembourg; Mexico; Netherlands; New Zealand; Norway; Poland; Portugal; Slovak Republic; Slovenia; Spain; Sweden; Switzerland; Turkey; United Kingdom; United States

and Development (OECD), it is 51%, compared to 21% for middle income countries and 6% for low income countries (Letseka, Cosser, Breier, & Visser, 2010).

Given the funding allocated to HE, this poses a huge challenge. The imbalances between intake and graduation have huge budgetary and financial implications. There is pressure from the authorities to minimise dropout but for the individual the costs of leaving the institution without graduating imply a loss in potential earnings and less preference in job choice is even bigger (Visser & Hanslo, 2005). In Africa particularly, universities are often faced with the choice between becoming or being a research-orientated institution for a smaller number of students or opening their doors to a diverse and bigger group of students (The European University Association, 2010). In the study on the aspirations of Grade 12 learners in, South Africa in 2005, Cosser and Sehlola (2009) report that in that year, 44% of Grade 12 learners planned to enter HE within three years while 37% wanted to do so directly after finishing secondary school. The Higher Education Management Information System (HEMIS) database for 2006 however, indicates that only 13% of the learners who wrote the final school examination entered HE in 2006. It is therefore important that those students who are accepted in HE, should succeed. Although many see higher education as a way to economic participation and a route to escaping poverty, those who participate and do not graduate often leave with a huge debt burden (Coughlan, 2006). To enable students to succeed, extended, bridging and foundation programmes for un- prepared or under- prepared students accessing HE were developed and offered internationally (Jacobs, 2010).

2.4.1.2 Access from a human rights perspective

On 10 December 1948 the General Assembly of the United Nations adopted and proclaimed the Universal Declaration of Human Rights in which also the right to education is guaranteed in Article 26 (United Nations (UN), no date). Education has to prepare people to address the demands of societies that are ever-changing. Therefore, what one wants to learn, what is offered by the educational system, and the ways in which one learns are determined largely by the nature of a society at any particular time.

2.4.1.3 Access from a changing societal perspective

As indicated in the introduction to this chapter (section 2.1), the biggest part of the workforce was trained for and worked as manual labourers in factories from the time of the Industrial Revolution. Higher education was not a requirement. Furthermore, what was needed to function as an adult could be learned in childhood and was sufficient to last a lifetime. This is no longer the case. Society now needs a knowledge-based workforce in conditions where knowledge develops faster than the education that can be offered. One also needs to think in inter-disciplinary terms. The rules and practices that determined success in the industrial economy needed (and still need) to be rewritten to be applied in an interconnected, globalised

economy where knowledge and expertise are as critical for the economy as other resources (Jarvis, Holford, & Griffin, 1998; Su, 2011; Belanger & Tuijnman, 1997; Kuh, Kinzie, Schuh, & Whitt, 2005; Scott, Yeld, & Hendry, 2007). The terms knowledge-based society or knowledge-based economy are used to describe the current age or time (Negash, Olusola, & Colucci, 2011).

The term "knowledge economy" was popularised by Peter Drucker in his 1959 book *Landmarks of Tomorrow* and later also used in *The Effective Executive,* published in 1966. He described the difference between the "manual worker" (p. 2) and the "knowledge worker" (p. 3). While the manual worker works with his (or her) hands, producing goods or services, a knowledge worker is someone who might be working at any of the tasks of "planning, acquiring, searching, analysing, organizing, storing, programming, distributing, marketing, or otherwise contributing to the transformation and commerce of information and those (often the same people) who work at using the knowledge so produced". The knowledge worker includes those people who work in information technology fields and who work as programmers, systems analysts, technical writers, academic professionals, researchers and so forth, although the term is also frequently used to include people outside of information technology, such as lawyers, teachers, scientists and even students (TechTarget, 2000-2012).

Knowledge does not know any boundaries. The Internationalisation of HE has become more of a reality than ever before. Whatever has been discovered in one part of the world needs to reach other parts as soon as possible. There is a need to facilitate knowledge creation in all parts of the world in view of its importance locally as well as internationally (Negash, Olusola, & Colucci, 2011).

Apart from the need for a worker who can produce knowledge, changing demographics and the developments in technology also have an influence on education and the kind of education people need. However, people live longer and have to work longer to earn their living. An initial education is no longer sufficient. People need to be lifelong learners (Merriam & Caffarella, 2007; Belanger & Tuijnman, 1997). Lifelong learning implies the acquisition of new knowledge all the time, taking responsibility for one's own learning, acquiring the skills of self-directedness, being reflective and knowing how to transfer knowledge between disciplines (Jarvis, Holford, & Griffin, 1998).

The knowledge needed by this 'new' workforce and society has also changed. Knowledge cannot be seen as something that one 'has'. Knowledge is constructed. It changes all the time as new knowledge is needed. Lifelong learners have to know how to make sense of knowledge (Su, 2011). People need to be multi-skilled in a multi-disciplined environment, able to adjust to change, think for themselves and be flexible in their thinking (Jarvis, Holford, & Griffin, 1998; Su, 2011). In this knowledge economy there is a need to compete effectively and to sustain future economic development. This is one of the great driving forces

behind increasing participation and the influx of students in HE (Osborne & Shuttleworth, 2004; Kuh, Kinzie, Schuh, & Whitt, 2005).

Ironically enough, one argument has been that these same processes of globalisation and the conversion of the educational system from a national welfare service to an international economy-driven market in Africa have become major barriers hindering implementation of the principle of equity in access to HE. Ogunluna (2010) and Negash, Olusola and Colucci (2011) report that most West African governments are commercialising HE, because many public institutions have been replaced by private HE institutions, making them inaccessible for many students.

As the HE system has evolved from a so-called elite one to one of mass entry (Pokorny & Pokorny, 2005), the system is faced with a more diverse student population. People from a disadvantaged social background, cultural minorities, the (physically) disabled, women and refugees are all facing various obstacles, leading to lower representation in HE. But the assumption that once possibilities for increased participation are available, under-represented groups will be able to grasp the opportunity, is not true. Appropriate mechanisms needed to be designed to expand HE to include diverse and disadvantaged groups, not only in Africa (Ogunlana, 2010), but also for underrepresented groups (also people with disabilities) in other so-called sophisticated education systems in countries such as Germany, Portugal, Sweden and Australia (Rollnick, 2010; Lee, 2010).

2.4.1.4 Access from a democratisation perspective

Education in South Africa is still a highly political issue – and this applies also to access to HE (Akoojee & Nkomo, 2007). Access has been perceived from two different viewpoints since 1994, each with a different outcome. In the period immediately following 1994 HE institutions adopted an ‘access for participation’ approach in order to increase participation and to allow especially black students to enter HE institutions previously closed to them. Recently, the approach has changed more towards an ‘access for success’ approach (Akoojee & Nkomo, 2007; Rollnick, 2010). “What is needed is not just widening participation but widening successful participation, i.e. access accompanied by equity of outcomes” (Scott I. , 2009, p. 5).

The concern with university access in South Africa has important implications for the way in which society is envisaged. The current need to transform should not to be left to happen by chance, if South Africa wants to reverse the fundamental racial imbalances of the past and HE wants to carry out its ‘public good‘ responsibilities (Badat, 2001; Singh, 2001, also cited in DHET 2012). The aim is further to raise the participation rate at universities from the current 16% to 23% by 2030. The attention should, however, be focused on increasing throughput. There has been a restructuring of HEI in South Africa since 1994 (see section 5). The latest

restructuring is suggested in recommendations by the National Planning Commission (2011) and the Department of Higher Education and Training (2012) to increase alternative study opportunities through technical schools, a college system and also other post-school opportunities for a more vocational training. Widening access to HE, however, is not an issue without its distinctive challenges.

2.4.2 Widening access

2.4.2.1 Structures to allow widened access internationally

In 2008 the European University Association (EUA) recommitted itself to widening access. It adopted a "European Universities' Charter on Lifelong Learning", calling on European universities, governments, their social partners and other stakeholders to proactively support the lifelong learning agenda and to assist European universities in developing their specific role in this context (The European University Association, 2010). The EUA surveyed HE institutions in Africa and Europe as well as student input and research on access and retention issues. They defined access "in relation to numeric increases and breadth of participation" (p. 92). Conceptions of widening access should, however, be positioned within appropriate definitions of quality (Akoojee & Nkomo, 2007).

In the UK the drive towards widening access started in the 1960's. The government widened access for students; mostly from the lower socio-economic or under-presented groups (Reddy & Moores, 2008; Pokorny & Pokorny, 2005), but also increased the opportunities for mature students to study part-time in the 1990's (Osborne & Shuttleworth, 2004; Straw, 2003; Osborne M. , 2003). "There is a legal case for equality but more importantly there is also a moral case for widening access", says Chris Jenks, Vice-Chancellor of the University of Brunel in London (Brunel University, 2012). This university, as an example of a UK university which practises widening access, aims its activities at students who demonstrate the potential to achieve the entry requirements for HE and who meet one or more of the following criteria: students with little or no family history of HE, students from a school or college with a poor record of entry to HE, students who come from a low income/low participation area, students who are disabled and people who have studied vocational courses. They also have special programmes for people who are classified as 'traveller, refugee or looked-after by a local authority' (Brunel University, 2012).

Another UK university offers 14-week short courses, assisting students to move on to a university degree. During their duration, such courses help students to learn the skills necessary for degree-level study. They also give students an insider's view of university life, allowing students the opportunity to decide whether they would really like to enrol in HE or not. (University of East London, 2012). At a third UK university, at its medical school, the

extended degree is “offered at a slower pace and with greater support for the first three years” (King's College London, 2012).

In the USA, several school intervention programmes (amongst them MESA, EQUITY2000 and summer camps) as well as community colleges were established to serve as the entry point for many underrepresented minorities and first-generation students to enter HE (Rollnick, 2010). An Academic Bridge Programme at Stenden University, Qatar has been designed to develop and improve the students’ English language skills to enable them to apply what they learn in class in real life situations and in their future professional careers (Stenden University, 2012).

Gross enrolment ratio (GER), as defined by UNESCO, designates a nation's total enrolment "in a specific level of education, regardless of age, expressed as a percentage of the population in the official age group corresponding to this level of education". It is furthermore an indication of the “general level of participation in a given level of education and indicates the capacity of the education system to enrol students of a particular age group (UNESCO, 1995-2012). In many African countries, education – GER in particular - is a major concern. In a number of countries, only a very few people from a small affluent elite group have access to good educational opportunities. On the continent as a whole, only 5% of the 20 to 24-year-old age group attends HE. In South Korea that number is 91% (Scott I. , 2009; Taal, 2011). Yet access does not automatically guarantee success and completion of studies.

In spite of all the measures that have been put in place to widen access, there is still a huge concern about student attrition in HE, the opposite of student success. Large numbers of first-year students are withdrawing from or dropping out of undergraduate courses (Scott I. , 2009; Ross, 2010). In a study done at one specific university in the UK, the dropout rate of first years was 21,8% in 2008 (Lowis & Castley, 2008). In a similar study conducted in Canada in 2009, it was 36% (Kennet & Reed, 2009). A study conducted at Debub University in Ethiopia, (cited by Negash, Olusola, and Colucci, 2011), shows that a large proportion of the students drop out of HE and that most of them are female students. Female students are therefore underrepresented numerically amongst graduates, but are also at a higher risk of non-completion (Negash, Olusola, & Colucci, 2011). Kuh, Kinzie, Schuh and Whitt (2005), also citing other research) report that, in the USA, 60% of students in public 2-year colleges and 25% of them in 4-year colleges and universities require at least one year of remedial coursework, and, that more than 25% of 4-year college students who have to take three or more remedial classes leave college after the first year. Of the 45% of students who start college and fail to complete their degree, less than 25% are leave because of poor academic performance. Most leave for other non-academic reasons which can, however, have a devastating effect on academic performance and social adjustment. In South Africa the Student Pathway Study, conducted by the Human Sciences Research Council (HSRC) in 2005

and reported on by Letseka (2009) reveals that 50% (p. 92) of students from universities and technikons dropped out between 2000 and 2003; 30% at the end of their first year. Only 22% of the students in this cohort graduated within three to four years.

It is not within the scope of this study to analyse the causes of attrition. It is, however, acknowledged as an important part of the debate about success (Ross, 2010). Transition and attrition research studies come mainly from the USA, the UK, Canada, Israel, Hong Kong and Australia. Much of the research since the 1970s has been about particular theoretical models, such as those of Tinto, Spady, Bean, and on their empirical validation by Terenzini, Pascarella and others (Evans, 2000). There are different perspectives on what constitutes academic achievement or success. These perspectives, as well as the different factors that can influence academic achievement or success, will be discussed in section 2.9.3 of this chapter. The specific structures put in place in South Africa are discussed in more detail in the following section.

2.4.2.2 Widening access in SA

As a result of the different level of spending on education for black people between 1948 and 1994, black people were also excluded from professional careers for a very long time. South Africa currently has far too few professional people to meet the needs of the whole population. There is, for instance, an enormous backlog of engineers to provide the infrastructure needed for a decent standard of living, a clean water supply, sanitation, housing, food, transportation and electricity, to name a few (Grayson, 2010). This is also the case for doctors, lawyers, teachers, accountants, etc. According to a study done by Cloete and Bunting in 2000, the throughput rates of black students was 3% in the engineering field, 12% in the natural sciences, and 9% in medicine (Cloete & Bunting (2000) in Akoojee & Nkomo, 2007).

The issue of widening access is addressed on different levels in South Africa. Outreach programmes are offered to children from pre-school to Grade 12, bridging programmes between secondary school and HE to extended degree programmes and foundation programmes, etc. School interventions are offered by the government but often also by non-governmental organisations, individuals, companies and churches (Smit, 2011). The programmes are usually offered to students from historically disadvantaged groups. Two of the attempts made by the South African government to increase the quantity and quality of learners doing mathematics and science are the 'Second Chance' programme which is commissioned by the Minister of Education, and the 'Dinaledi' (a seSotho word meaning 'Stars') projects. There is scepticism about the Dinaledi project, "as it has been struggling to live up to its namesake in that it has produced a few twinkles but not many stars'', says Monare, in a *Sunday Times* article published on 7 September 2003 in Mabila, Malatje, Addo-Bediako, Kazini and Mathabatha (2006, p. 296).

The "Second Chance Project" was launched in 2008 to give learners who failed three subjects or ‘fewer in the NSC exams the opportunity for remedial learning through classroom-based tuition. The initiative was a partnership between the South Africa's National Youth Development Agency (NYDA), the Department of Education and the Matthew Goniwe School of Leadership and Governance. It was supposed to be implemented in conjunction with the national and provincial education departments. The class of 2008 was used as a pilot, with the programme expected to be rolled out every year (Bathembu, 2009). According to the information on the NYDA web site, The "Second Chance Project" was going to be piloted with the help of Star Schools in four provinces namely, Eastern Cape, Gauteng, KwaZulu-Natal and the Western Cape. Tuition was to resume on 19 February 2011. To be considered for the programme learners must have failed a maximum of four subjects. Priority would be given to English, Mathematics (not Mathematical Literacy), Physical Science and Accounting, and learners must have attained at least 25% or higher per subject (National Youth Development Agency, 2012). No updated information about this project could be found at the time when this study was conducted.

2.5 Access programmes

2.5.1 Research on access programmes

As indicated earlier, much research has been done and many articles have been published about access programmes internationally. The reasons for research on this issue vary considerably and can be organised into different categories.

Some research is aimed at evaluating the value of access programmes (Akoojee & Nkomo, 2007), while others compare the performance of students from specific (access or advanced) programmes with students who did not participate in these programmes (Scott, Tolson, & Huang, 2010; Fernando, Prescott, Cleland, Greaves, & McKenzie, 2009). According to Wood and Lithauer (2005), cited in the CHE report (2010), “students who perform successfully in foundation programmes, tend to perform better in later degree programmes than students with similar academic profiles who are admitted directly into mainstream programmes” (p. 197). This is also confirmed by Mabila and others in their study (Mabila, Malatje, Addo-Bediako, Kazini, & Mathabatha, 2006).

Other research on access programmes focuses on student selection (Trapmann, Hell, Hirn, & Schuler, 2007). Some seek to develop a framework for the placement of university students in specific programmes (Jacobs, 2010) or to develop and test an assessment tool for predicting first-year student achievement and progression (Lowis & Castley, 2008; Downs, 2005; Dursan, 2012) or success in HE in general (Naumann, Bandalos, & Gutkin, 2003; Ramrathan, Manik, & Pillay, 2007).

Scott, Tolson and Huang's (2011) research on access reports on how to better advise newly enrolled students in specific college programmes to prepare them (and their parents) for the level of effort that may be required to be successful in science-related fields of studies. Another motivation for research conducted in or about access programmes is to indicate what kind of student should be admitted to a specific field of study (Eiselen, Strauss, & Jonck, 2007). A number of writers report extensively on student retention (Haselgrove, 1994; Levitz & Noel, 1989, 2000; Yorke, 1997 reported in (Lowis & Castley, 2008; Kennet & Reed, 2009). Student retention has a direct impact on success.

2.5.2 Different alternative access programmes

Alternative access to HE is highly debated nationally and internationally (Van der Merwe & De Beer, 2006; Rollnick, 2010; Zhu, 2010; McKenzie & Schweitzer, 2001; Giuliano & Sullivan, 2007; Reddy & Moores, 2008; The European University Association, 2010; Zaaiman, Van Der Flier, & Thijs, 2000; Pascarella, Pierson, Wolniak, & Terenzini, 2004) a few of the authors who have published articles in this field.

Rollnick (2010) and Lee (2010) both report different types of access programmes offered internationally. Rollnick reports about 50 access programmes in England, Scotland, Wales, Ireland, Canada, the USA and Australia and 45 programmes, mostly science-based access programmes in Southern Africa and predominantly in South Africa (Rollnick, 2010). Mabila, Malatje, Addo-Bediako, Kazini and Mathabatha (2006) also mention a few programmes in South and Southern Africa. Osborne (2003) reports on a comparative study done in six countries - Australia, Canada, England, Finland, France and Scotland – analysing the policy and practice of these countries regarding access. Lee's survey (2010) was prepared by the European Access Network (EAN) based in the United Kingdom, reporting on the research and development work in the field of access to higher education for disadvantaged and underrepresented groups. Of the 141 questionnaires sent out by the network, a total of 72 from nine countries (Sweden, the Netherlands, Spain, Germany, Australia, South Africa, Finland, Ireland and the UK) were completed fully enough to allow further analysis.

In the USA and UK access programmes are mostly offered by community colleges or colleges of further education, distinguishing these programmes from HE (Rollnick, 2010). Many school outreach programmes have also been established in the USA and other countries, South Africa included, trying to address the backlog these students have in especially mathematics and sciences, even before they enter HE.

In South Africa the need for a differentiated system of university education has long been recognised, as mentioned in section 5 on the history of education in SA. In 2006 the Department of Education informed universities that they had to restructure their access programmes into credit-bearing extended degree programmes with a certain minimum

number of foundation modules (equivalent to 0.5 HEMIS credits). These access programmes have different names in different institutions: extended degree programmes (EDPs), foundation programmes, extended curriculum programmes (ECPs), first-year academies, bridging programmes or second-chance programmes (Council on Higher Education (CHE), 2012).

Not all institutions can or should fulfil the same role. This has been reflected upon in a number of publications and policy documents, such as the *White Paper on Higher Education* in 1997, the discussion document of the Council on Higher Education (CHE) on the Size and Shape of Higher Education (2000) and the South African National Plan for Higher Education (NPHE) (2001). Some of the reasons for institutions to find the most appropriate approach to enhance each one's ability to meet national needs; to provide a diversity of programme offerings to a diverse group of people; to provide for flexibility and innovation throughout the system; and to increase overall participation rates in HE in South Africa. These issues are repeated in the National Development Plan released in 2011 as well as by the Green Paper for Post-School Education and Training circulated by the Department of Higher Education and Training (DHET) in March 2012, both with an invitation to the public to respond to the suggestions. This is also an indication that this is an on-going debate.

According to Grayson (2010), there are two models of bridging from high school to university. The first is a phased transition, which matches both the end of the previous level and the beginning of the coming phase. The second is the intermediate level, with discontinuities at both ends and which requires students to shift from one level to the other. A bridging programme is typically necessary to move from the one to the other. Access programmes may also be offered through a foundation year, and extended degree or augmented programme. These programmes entail the curriculum of one academic year being offered over a longer than normal period. It is therefore viewed as involving a reduced workload. In South Africa, with its history of separate and different education, these terms are not perceived without prejudice and concern. Different access programmes in South Africa were already discussed in section 2.5 of this chapter.

For the sake of this study and in line with the categorisation offered by Lee (2010) access programmes are categorised into three groups: pre-entry, entry and post-entry programmes. There is, however, overlap between the categories and programmes. Irrespective of what kind of programmes they are, they all want to deliver successful students.

2.5.2.1 Pre-entry programmes

Pre-entry programmes are defined as programmes offered mostly to students before they enter HE and often before they have written the exit examination of the phase prior to entering HE. These programmes are aimed to raise the awareness, aspiration and attainment of school

pupils to encourage them to consider higher education (often a specific HEI) and to provide them with the necessary support to achieve the objective. In the USA and in South Africa several school intervention programmes are available. Summer camps and summer schools are also popular in the USA (Rollnick, 2010; Lee, 2010).

2.5.2.2 Entry programmes

Entry or access programmes are one step closer to entering HE (Lee, 2010). In some cases students may have written the exit examination of the previous phase, but have not necessarily passed the examination with results good enough to be allowed into HE. This is the case in the programme investigated in this study. In some of the programmes students are offered the opportunity to re-write some components or the whole of the exit examination, or in some cases no examination is required. These programmes usually offer a structured admissions process for students who successfully complete the programme, if no formal examination is written (Smit, 2011).

According to Grayson (2010), there are two models of bridging the move from high school to university. The first is a phased transition, which matches first the end of the one (school) and then the beginning of the next (university) phase to the appropriate level. The second is the intermediate level, with discontinuities at both ends and which requires students to shift from one level to the other. A bridging programme is typically necessary to move from the one to the other. Access programmes may also be offered through a foundation year, as well as extended degree or augmented programmes. These programmes refer to the curriculum of one academic year being offered over a longer than normal period (Grayson, 2010; Rollnick, 2010).

These programmes include the following:

- Full-time (one-year) preparation course to give access to specific courses to those who do not meet the entry requirements;
- Foundation year programmes, often targeting mature (older) students to bring them up to speed before admission. Among other things, extended, bridging and foundation programmes for unprepared or under-prepared students accessing HE were developed and are being offered internationally (Jacobs, 2010). In the UK this initiative was launched in the 1960s (Osborne & Shuttleworth, 2004; Straw, 2003; Osborne M. , 2003);
- Bridging programmes (i.e. Intro SET at Vaal University of Technology. SciMathUS at Stellenbosch University) - to enhance specific skills or subject knowledge in subjects such as mathematics, science, language and academic literacy, and prepare learners for entry to programmes in specific programmes in specific faculties (Engineering and Technology, Medicine, etc.) (Lee, 2010);

- Foundation programmes for international students to prepare them for alternative entry examinations at a specific HEI (i.e. the University of Amsterdam). In the USA and UK access programmes are mostly offered by community colleges or colleges of further education, distinguishing these programmes from HE (Rollnick, 2010; Lee, 2010);
- Specific courses or programmes that provide alternative routes to higher education; sometimes specifically designed to increase access and participation for specific (minority) groups, such as programmes in Australia (Access Melbourne, The Foundation Programme at the University of Zululand in South Africa) or programmes for disabled students to encourage persistence and student support (Lee, 2010). The medical school at King's College in London (2012) offers an extended degree at a slower pace and with greater support for the first three years to students;
- Programmes to provide an initial first step for students into the education process and gradually build a pathway between further education and higher education such as the Access For Success Programme at Wits University in South Africa, the CPP (Career Preparation Programme) at the University of the Free State, South Africa and the SciMathUS (Science and Mathematics at Stellenbosch University) bridging programme.

  The latter programmes can be grouped into:

  - transition courses between secondary school and HE;
  - orientation and adjustment to HE on an academic, social and cultural level;
  - information programmes to ensure that students understand the pros and cons of entering higher education, and that the students have the necessary information to make a right decision about the courses they choose to meet their career and personal aims and objectives. These programmes aim to
    - ease students into university life;
    - offer sessions where specific academic skills for students prior to commencing their degree programmes are provided;
    - offer information on the services available at the university; and
    - orientate students to their new environment. (Hay & Marais, 2004; Smit, 2011; Malan, 2008).

As an example, the University of East London (2012) offers 14-week short courses, assisting students to move on to a university degree. These courses help students to learn the skills necessary for degree-level study. They also give students an insider's view of university life, allowing students the opportunity to decide whether they would really like to enrol in HE or not.

2.5.2.3 Post-entry programmes

The distinction between entry and post-entry programmes is also not always that clear as indicated above. While some foundation programmes offer the first modules of a degree programme, they can either be classified as entry or post-entry. Post-entry programmes also vary in what they have to offer. Some create a welcoming and stimulating environment for learning while others provide support through short workshops, specific skills training, tutoring, mentoring or counselling, all aimed at ensuring that students stay on course and complete their studies successfully (Lee, 2010). The programmes are offered internationally by many HEIs. Some of these programmes are accredited and certificates of competence or attendance can be obtained by the participants (Stellenbosch University, 2012).

2.5.3 Access in South Africa

2.5.3.1 Entry requirement to enrol in HE in South Africa

Students entering HE in South Africa since 1 January 2009 must have obtained the National Senior Certificate (NSC) with a minimum of 30% in the language of learning and teaching of the HE institution as certified by Umalusi, coupled with an achievement rating of a minimum of 4 (Adequate Achievement, 50-59%) in four subjects chosen from a designated 20-credit NSC subject list. Students may, however, also be accepted at the discretion of the Senate; or by qualifying for Mature Age Exemption (Umalusi, 2010, p. 27) .

2.5.3.2 School learners who wrote and passed the NSC examinations in Mathematics and Physical Sciences: 2008 - 2011

While leaving home and preparing for a career should be a wonderful experience, for many learners the end of Grade 12 is a time of disappointment and disillusionment as their final school results do not allow them to apply for HE - this is, if the learners even managed to progress to Grade 12. While the general matric[7] pass rate over the past three years has been around 70%, only 38% of all the students who had been in Grade two 10 years before passed matric in 2011. The biggest drop-out takes place between Grades 10 and 12 (Spaull, 2012). Below are the numbers of students who wrote and passed the NSC examinations in Mathematics and Physical Sciences in the cohort that was investigated in this study. As 50% is considered as the minimum requirement to enter HE, it is a pity that these numbers are not available in the public domain.

[7] Matric is used as a synonym for Grade 12 or matriculation.

Table 2.1 Number of students in South Africa who wrote the NSC examinations in Mathematics: 2008 – 2011*

	Number of students						%			
	Written	**Failed**	**Passed with 30%**	**Passed with 40%**	**Passed with 50%**	**Passed with 60%**	**Passed with 30%**	**Passed with 40%**	**Passed with 50%**	**Passed with 60%**
2008	298 821	162 318	136 503	89 788	63 038	42 323	45,7%	30,0%	21,1%	14,2%
2009	290 630	156 841	133 789	85 491	52 866	31 786	46,0%	29,4%	18,2%	10,9%
2010	263 034	138 285	124 749	81 374	Not available	Not available	47,4%	30,9%	Not available	Not available
2011	224 635	120 602	104 033	67 541	Not available	Not available	46,3%	30,1%	Not available	Not available

Table 2.2 Number of students in South Africa who wrote the NSC examinations in Physical Sciences: 2008 – 2011*

	Number of students						%			
	Written	**Failed**	**Passed with 30%**	**Passed with 40%**	**Passed with 50%**	**Passed with 60%**	**Passed with 30%**	**Passed with 40%**	**Passed with 50%**	**Passed with 60%**
2008	217 300	98 094	119 206	61 480	32 524	16 620	54,9%	28,3%	15,0%	7,6%
2009	220 957	139 450	81 507	45 531	22 329	10 308	36,9%	20,6%	10,1%	4,7%
2010	205 364	107 104	98 260	60 917	Not available	Not available	47,8%	29,7%	Not available	Not available
2011	180 585	84 144	96 441	61 109	Not available	Not available	53,4%	33,8%	Not available	Not available

*collated and updated over years from the National Department of Education website (Department of Basic Education, 2012)

In 2008 former Senior Certificate (SC) was replaced by the new National Senior Certificate (NSC). Not only did the school-leaving examinations change, the structure of the curriculum also changed (Schöer, Ntuli, Rankin, Sebastiao, & Hunt, 2010). Students who matriculated prior to 2008 could take subjects and write the examinations on Higher or Standard Grade. Only a small number of students chose to take Mathematics as a subject at all up to 2007. Since the new curriculum has been implemented, Higher and Standard Grades were abolished and Mathematics is a compulsory subject. Students are, however, able to choose between Mathematics and Mathematical Literacy (Department of Basic Education, 2012). The post 2008 school-leaving students were taught using an outcomes-based education (OBE) system whereas the pre-2008 school leavers were taught and assessed on a skills- or content-based learning system, organised into Higher and Standard Grade courses. From the beginning, the OBE system was flooded with criticism and many were convinced that students would learn less than before (Schöer, Ntuli, Rankin, Sebastiao, & Hunt, 2010). In September 2011, the South African Minister of Basic Education approved the National Curriculum Statement Grades R-12 as the national education policy to be implemented incrementally between 2012 and 2014 (Republic of South Africa, 2011). The students and their results investigated in this study are products of the OBE system.

The average South African GER[8] in HE was 12% in 2000 and 16,3% in 2007 (Department of Education, 2009). By 2006, the participation rate of South African Black Africans in HE was still a very low 12% (up from 5% in 1986). The situation was almost the same for Coloured students; 9% in 1986 and 13% in 2006. In contrast, the GER for whites was steady at around 60% since 1986, while the rate for Indians increased from 32% in 1986 to 51% in 2006. Although there has been an increase, the GER in South Africa is still very low compared to the average of 60% in developed countries (Department of Education, 2009). In spite of many universities expanding their student numbers between 2001 and 2004 - head-count enrolment increased by 28,8% (Department of Education, 2009) - the system's output performance remained below the targets set by the National Plan for HE. The drop-out rates were also high, indicating low levels of efficiency in the system (Department of Education, 2009).

Although South African tertiary institutions succeeded in increasing access for students from disadvantaged backgrounds after 1994, the number of students able to complete a four-year degree in the minimum number of years has not increased accordingly (Van der Merwe & De Beer, 2006). In the Soudien Report this is referred as the 'revolving door syndrome', where more students from previously disadvantaged groups are admitted to university, but many of them drop out or are excluded after a year or two because of poor academic performance (Soudien, 2008).

The term 'throughput rate' is part of the jargon of managerialism, efficiency and effectiveness, quality assurance and control, inspection and accountability that has become a prominent feature of the current educational landscape. Whatever is undertaken must be justified in terms of an increase in productivity. Throughput rates have important implications for universities, considering that the National Plan for Higher Education (2001) stipulated that government funding is directly linked to throughput (access for success) rather than enrolment (access for participation) rates (Ross, 2010; Akoojee & Nkomo, 2007).

In South Africa the implementation of a new education system coincided with the democratisation and social restructuring of our country. The first democratic elections in 1994 introduced a new era in the history of South Africa and as a consequence, in education too. Not only schools, but also HE was transformed. The Constitution and the Education Policy of South Africa endorse equity and social justice for all (Department of Education, 2001). The changes have been numerous and radical since then.

[8] Gross enrolment ratio (GER), as defined by UNESCO, designates a nation's total enrolment "in a specific level of education, regardless of age, expressed as a percentage of the population in the official age group corresponding to this level of education". It is furthermore an indication of the "general level of participation in a given level of education and indicates the capacity of the education system to enrol students of a particular age group (UNESCO, 2009).

2.5.3.3 Current enrolment statistics in HE in SA

The latest statistics published by the DHET show that enrolments for the field of Science, Engineering and Technology (SET) have grown by 4,4% per annum between 2000 and 2009, and graduation rates in these areas have increased by 5,5% per annum (see Table 2.3 below), indicating improving throughput rates (Department of Higher Education and Training (DHET), 2012).

Table 2.3 South African graduate output and growth by major field of study 2000-2010

Fields of study	Actual graduates											Average annual
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	
Science, engineering & technology	24 136	24 995	26 630	29 546	31 443	33 499	35 555	36 429	38 820	40 973	41 156	5.5%
Business/ management	19 912	22 590	24 217	26 954	29 327	28 144	30 108	31 062	31 871	33 788	40 751	7.4%
Education	15 568	18 737	21 487	24 242	29 253	29 054	28 554	28 337	29 636	35 532	37 665	9.2%
Other humanities	28 581	25 236	24 955	24 988	27 060	29 355	30 404	30 788	32 844	34 517	30 015	0.5%

Excludes 3098 graduates with unknown fields of study (Department of Higher Education and Training (DHET), 2012, p. 38)

South African universities in general are, however, characterised by relatively low success rates: 74% in 2010, compared to a desired national norm of 80%. This results in a graduation rate of 15% – well below the national norm of 25% for students in three-year degree programmes in contact education (Department of Higher Education and Training (DHET), 2012). In contact universities, well under a third of students complete their courses in three years and one in three graduates do so within four years. “This represents a distressing blow to the ambitions of tens of thousands of drop-outs each year … as well as a waste of the resources of both parents and the state” (Department of Higher Education and Training (DHET), 2012, p. 41). Improving the throughput rates should be the top strategic priority of university education.

2.5.3.4 Academic Development Programmes (ADPs) or Academic Support Programmes (ASPs) in South Africa

In the early 1980s, most HE institutions in South Africa started offering some sort of alternative access programme in mostly science and/or engineering fields of study for students from the so-called previously disadvantaged groups. Every piece of HE policy since 1996 has set access as one of the most important goals for the HE system in the democratic transition

(Council on Higher Education (CHE), 2010). It still is an issue because this is reiterated in the newly published Green Paper for Post-School Education and Training in 2012 which urges "institutions to develop realistic bridging programmes that can support individuals who do not have all the knowledge and experience required for the education programmes of their choice" (Dweck, 2006).

Academic development or support programmes developed from the recognition that some students entering HE are ill-prepared for it. Rollnick (2010) distinguishes between the following kinds of programmes.

- Extra tutorials, enrichment support and mentoring. The idea behind this offering is that students only need to fill gaps in their knowledge – they have already reached the levels required.
- Unsupported slow stream. This entails spreading the content over double the time required to finish the programme.
- Bridging programmes. These programmes precede the regular programmes and are usually "backward looking" (Rollnick, 2010, p. 18) in the sense that the same material that has been studied in school, is offered again to prepare students for future studies.
- Foundation programmes. These programmes are "forward-looking" – course-work of the regular programme to follow is unpacked, also to prepare students for future studies. These programmes have also been described as phased transition programmes.
- Modified mainstream first year and augmented programmes. In these programmes, the content of the first year is offered over two years.

While the conception of Academic Development (AD) (access) differs markedly from the way it was conceived, there are critical views about alternative access routes into HE, internationally and in SA. One argument is that the bridging programmes developed by several HE institutions (HEIs) are "quick-fix solutions to providing an alternative route for learners who could not meet the entry requirements to HE courses" (Nair, 2002, p. 94). Another argument is that these programmes are institution-based and lack uniformity in terms of duration and curriculum (Akoojee & Nkomo, 2007; Nair, 2002). Also, these programmes "do not provide any certificate qualification or mobility" (p. 94), while on the other hand, statistics about school leavers indicate that many of them are not in demand of what they should have learnt in school (Letseka, Cosser, Breier, & Visser, 2010). In his research, conducted under the auspices of the Vice-Chancellor of the Technikon Witwatersrand, Nair developed a model that could be a "proper intermediate structure between the school sector and the HE sector to cater for the lower achievers, as well as those who are underprepared at the school exit point". He also suggests that "it is high time to consider providing alternative

median exit points with undergraduate certificate qualifications that could serve as a part of a coherent learning pathway for those who may fail to reach the exit point of HE degrees and diplomas without interruption" (Nair, 2002, pp. 94-103).

Some Academic Development programmes (ADP's) are still perceived as marginal to institutional practices, "isolated and being taught in remote buildings … often by white women (former teachers) … appointed in junior positions" (Rollnick, 2010, p. 26). This is also the argument of Tinto (2006) who says that "regrettably faculty involvement is still more limited than it should be to enhance student retention" and adds that "the actions of the faculty, especially in the classroom, are key to institutional efforts to enhance student retention" (p. 5). If the institution (or Tinto's faculty) shifts the responsibility of effective teaching and learning, and by extension redress practice, to the periphery of the institution (Akoojee & Nkomo, 2007), the problem will persist. This goes against the core of epistemological access (Rollnick, 2010). Epistemological access is about "learning how to become a participant in academic practice" (Morrow, 2009, p. 78).

Equally alarming is the fact that being disadvantaged is seen by some as the problem of the student – specifically "that black students are inherently deficient" (Mabokela, 1997, p. 431, cited by Akoojee & Nkomo, 2007) and that it is not the result of an education system. This is evident in the traditional race-based intake into ADP's despite the assurance that extended curricula are for all learners. SciMathUS, an example of an access programme offering students an alternative access route into HE, uses the term 'educationally disadvantaged' when a student is considered as a candidate for the programme. This is defined by a students' home, school and personal circumstances (Smit, 2011).

It is argued that current Academic Development (AD) initiatives as a means of achieving `access with success' can only deal marginally with the transformation agenda in South Africa (Akoojee & Nkomo, 2007).

2.6 The programme that forms part of this research as an example of an access programme

The bridging programme that is discussed in this study, SciMathUS, was launched at Stellenbosch University in 2001. The aim of the programme is to allow educationally disadvantaged students whose Grade 12 Mathematics and Physical Sciences results are below the standard entrance scores for admittance to HE, an opportunity to improve their scores in these subjects and then reapply for HE. This programme therefore aims to bridge the gap for motivated students between secondary school and HE to allow them to compete on par with other applicants to universities for degree programmes in Engineering, Natural Sciences, Accountancy, Health Sciences and their respective applied fields (Smit, 2011).

In this programme, students have a choice between two streams: Science and Mathematics and Accounting and Mathematics. Students who choose the Science stream rewrite both the Physical Sciences and Mathematics examinations of the National Senior Certificate (NSC) at the end of the bridging year. Those enrolled in the Accounting stream rewrite only the Mathematics NSC examination. The Faculty of Economic and Management Sciences at Stellenbosch University offers and assesses the students in the Introduction into Financial Accounting and Introduction into Economics courses. These courses are also in line with the curricula of the extended degree programme offered to first-year students in this faculty. Students who have attended SciMathUS the past 11 years increased their results in the three core subjects by more than 15 percentage points on average (Smit, 2011).

In line with Astin (1993), who claimed that academic progress can only materialise together with personal development, the students are not only encouraged to significantly improve the results in the core subjects, they are also encouraged to develop personally. The foundation for personal development is laid at the beginning of the year at a camp and enhanced in a Life Skills course during the year. Students set their own goals and are assisted with skills on how to achieve these. These skills include very practical issues such as time management and study skills, but also higher-order skills such as thinking and problem-solving skills as well as academic literacy skills, skills very necessary to perform well in HE.

SciMathUS follows a hybrid Problem-based Learning (PBL) philosophy, where students are encouraged to take responsibility for their own learning. In brief, the approach entails that students are academically challenged with real-life problems. Students meet and discuss these problems in groups. Learning in these groups is driven by the challenge to resolve the problem. Students discuss what they already know about the topic involved as well as possible ways to resolve the problem, regardless of how unfeasible these solutions may seem. The teacher acts as a facilitator in this process. Once every option is laid on the table, the students research the problem by themselves. When they resume, they share their findings and together decide on the best way to resolve the problem, thus improving their problem-solving skills. Since students have to discuss issues in their groups, this approach enhances students' ability to think through problems logically and develop solutions relevant to the tasks at hand (Stenden University, 2012; Smit, 2011; Malan, 2008).

It is not within the scope of this research to discuss or evaluate the value of PBL, academic literacy or any of components offered in the programme. The core elements of the programme are merely mentioned. Some of the added benefits of PBL are, however, that students experience and realise the discipline needed for self-study and self-motivation, as the group is dependent on each member making an equal contribution. Students also learn how to communicate with each other productively in order to work as a group and to learn from one another. When each member realises that responsibility, they cooperate because they all want

to learn and do well. When they succeed and perform well, it is a boost for their self-confidence and they want to perform even better. This enhances learning (Abrandt Dahlgren & Dahlgren, 2002; Nuutila, Törma, & Malmi, 2005; Kieser, Herbison, & Harland, 2005; Gukas, Leinster, & Walker, 2010; Dolmans, Wolfhagen, van der Vleuten, & Wijnen, 2001; Tan, 2004).

Between 2001 and 2011, 643 students successfully completed the programme. Between 2008 and 2011 the programme has had a pass rate of more than 95%; 84% of the students who attended the programme obtained more than 50% in Mathematics and 88% obtained more than 50% in Physical Sciences and could therefore apply to be admitted into HE – 50% is the minimum requirement for entrance into HE, although these criteria also change. Even though students from all over South Africa apply and attend this programme, they are encouraged to enrol at any HEI in South Africa after completing the programme. More than 100 former students from this programme had graduated by the time this study was conducted. A number of them have also received postgraduate degrees in Science, Engineering and Commerce related fields; a few are enrolled in PhD and Master's degree studies.

From the total population of more than 600 students who attended the programme the past 11 years, a sample of 239 was chosen for this study. Of these 239 students who attended the programme, 179 (75%) enrolled at Stellenbosch University in the year following SciMathUS. Sixty nine (69) students enrolled in the Faculty of Science, 45 in Economic and Management Sciences, 22 in the Faculty of Engineering, 16 in the AgriSciences Faculty, 15 in the Faculty of Social Sciences and 12 in the Faculty of Medicine and Health Sciences. Of these students, 77 (43%) earned more than 50% of the credits (considered a pass). One hundred and forty one (79%) of the students however earned more than one third of the credits during their first year (necessary to continue to their second year).

On the basis of the access for participation argument, SciMathUS therefore has a success rate of 75%; counting only the students who enrolled at Stellenbosch University. If the number of students enrolled at other HEIs is added, this rate will be even higher. To determine the access for success rate, this study determined at the students' performance at the end of their first year of study in HE, knowing that this is not the ultimate measurement of being successful in HE, as also indicated by Pascarella, Pierson, Wolniak and Terenzini (2004). Depending on whether 50% or 30% is perceived as a pass as discussed in Chapter Four, section 4.4.3.1, SciMathUS has an access for success rate of 43% or 79%. These issues are discussed in more detail in Chapter Four in section 4.6.1. To adhere to the complete access for success argument, a follow-up study will have to be done over time to determine how many of these students have graduated.

2.7 Selecting students for access programmes

With the influx of students into HE internationally, the selection of students has been identified as a critical issue faced by HE institutions. The identification and selection of educationally or historically disadvantaged students or minority groups with the potential to succeed in especially mathematics- and science-based programmes is a particularly pressing problem (Cliffordson, 2008; Jacobs, 2010; Scott, Tolson, & Huang, 2010; Ogunlana, 2010; Rollnick, 2010; Yeld & Haeck, 1997). According to Zaaiman (1998), research projects tend to focus on isolated aspects of the problems of selection and do not give an overall picture of selection issues. Selecting a student is just as much of a responsibility as rejecting someone (Zaaiman, Van Der Flier, & Thijs, 2000) and making wise access decisions is morally imperative (Coughlan, 2006), "especially … when selecting previously disadvantaged students" (Zaaiman, Van Der Flier, & Thijs, 2000, p. 4).

Zaaiman (1998) reports that the following issues affect selection of students for higher education:

- Growth in applications for post-secondary study;
- Heterogeneity of the student population, with respect to previous educational opportunities and level of preparedness for further study;
- Identification of students with the potential to succeed, despite previous educational disadvantage;
- Lack of students in science, engineering and technology programmes;
- Under-representation of black students, especially in science, engineering and technology programmes;
- Under-representation of female students from disadvantaged backgrounds in higher education;
- High failure and low retention rates, especially among disadvantaged students;
- Lack of transparency in selection practices;
- Lack of validated selection instruments and policies;
- Lack of published research results on which to base new admissions policies and practices (p. 22).

She adds that, specifically in South African research, there is uncertainty about the validity of using final school results for the prediction of success of disadvantaged applicants in further education. This is also the view of Yeld and Haeck (1997).

Other literature on access to higher education indicates that equity in tertiary education is also an issue internationally. Admission testing is a highly complex and contested issue and has been researched by a number of researchers such as Altink (1987), Yeld and Haeck (1997), Mabila, Malatje, Addo-Bediako, Kazini, & Mathabatha (2006), Fastre, Gijselaers and Segers

(2008), Reddy and Moores (2008), Cliffordson (2008) and Ross (2010). Higher education institutions apply selection processes when they have to allow specific students with specific scores to enrol in specific degree programmes. While selection must always serve the aims of the programme for which the selection is done, Zaaiman, Van Der Flier and Thijs (2000) advise that selection should also be fair, effective and efficient. On the other hand, it is often pointed out that satisfying the requirements of fairness and effectiveness in an efficient and acceptable way is difficult (Altink, 1987; Zaaiman, Van Der Flier, & Thijs, 2000; Schwartz, 2004).

Zaaiman, Van Der Flier and Thijs (2000) also argue that the main aim of selecting students for HE programmes should be to identify students who are most likely to succeed in the specific academic programmes they are selected for. It is often easier to defend the use of skill-orientated tests for selection than the use of non-specific reasoning tests or measurements of personality (Zaaiman, 1998). Rollnick (2010) alerts us to the idea that it is more difficult and a very different matter to select students with potential than selecting students for highly selective programmes or selecting students for reasons such as widening access. "Selecting for access courses is slightly different. As in the case of competitive selection, the emphasis is on finding the students who have the best chance of success but there is the additional requirement of providing access to students who have been disadvantaged" (Rollnick, 2010, p. 68). This is especially true in a society where past injustices have left members of certain groups more disadvantaged than others. The social and financial costs of selecting the wrong students are high (Negash, Olusola, & Colucci, 2011; Zaaiman, 1998). The selection of the students with the highest probability of succeeding may lead to underrepresentation of disadvantaged groups. The selection of more disadvantaged students through the implementation of affirmative action policies may lead to a smaller probability of success in the selected group, as well as the rejection of qualified, privileged applicants. In reality, selected students will either pass or fail and some rejected students would have been able to pass. The selection practitioner must therefore find the optimal fit between fairness and effectiveness for the required situation (Zaaiman, 1998). This is a huge challenge, as also confirmed by Smit (2011) and the selection committee that deals with the selection of students for SciMathUS.

2.8 Predicting success

2.8.1 The debate about the predictive validity of final school results for success in HE

Final school results as an example of an achievement test can be expected to correlate with success in HE because the assumption is "that a student needs to have some mastery of knowledge and skills offered in previous education to be able to profit from subsequent

education" (Altink, 1987, p. 2). However, if the quality of schooling varies considerably (like in South Africa), the use of these tests for the purpose of selection, evaluation or prediction of success is questioned. It may imply discrimination against students who have not had good schooling (Koch, 2007; Rollnick, 2010; Zaaiman, Van Der Flier, & Thijs, 2000; Naumann, Bandalos, & Gutkin, 2003; Nel & Kistner, 2009; Griesel, 1999, updated 2000; Maree, Pretorius, & Eiselen, 2003). In developed countries with stable political and educational systems and even for students in South Africa who obtain Grade 12 results with high grades, these scores can however be perceived as good predictors to rely upon. Research was also conducted to determine the correlation between school results and performance in HE in South Africa (Du Plessis & Gerber, 2012; Botha, McCrindle, & Owen, 2003; Maree, Pretorius, & Eiselen, 2003; Potgieter, Davidowitz, & Venter, 2010), resulting in interesting outcomes. A huge difference between the academic ability of former SC matriculants and the NSC school-leavers was also revealed by Schöer, Ntuli, Rankin, Sebastiao and Hunt (2010) when they compared the performance of students in Economics 1 and Computational Mathematics of 2008 and 2009 and analysed the NSC Mathematics marks of the one group relative to the former Higher Grade (HG) Mathematics marks of the other.

Before 1994 South African learners from the different race groups wrote different final school examinations. Since the results from these students were not seen as comparable, the validity of using these results for selection into HE was also questioned and therefore also generally regarded as the most unreliable predictor of future academic performance (Zaaiman, 1998; Yeld & Haeck, 1997). Although students who finish school now all write the same examination and there is only one Department of Education, there is still a huge difference in the type of education offered to the learners in this country. The argument by Zaaiman (1998) that the low marks of most South African matriculants (so-called Grade 12 learners) "are ascribed to a lack of facilities, equipment and capable teachers"(p.10) and to the fact that the "uncertainty about the predictive validity of end-of-school results for the further academic performance of disadvantaged students, in particular, thus continues to exist even after the disbanding of the race-based educational departments" (p.11), unfortunately still reflects a reality in 2012.

Ross (2010), and others, indicate that, although the Grade 12 performance of students does correlate with tertiary academic performance and cannot therefore be completely disregarded as a predictor of tertiary academic performance, it is also accepted that it cannot be used as a sole predictor of academic success in HE (Griesel, 1999, updated 2000; Griesel, 2003; Altink, 1987). Most of this research about the predictive validity of Grade 12 result on the success of students in HE was conducted while the previous matriculation system was still in place. Jacobs (2010) argues that an important advantage for the use of school achievement when an institution has to decide whether a prospective student should be allowed to enrol in HE (and therefore us the Grade 12 results as predictor for future university performance) is that school

results are available at no cost prior to registration. If more information could be available to profile the individual student further in advance, then careful analyses and therefore better informed decisions and a better 'match' between student and programme could also be achieved.

Except that school results are questioned as an indication of most school leavers' real potential in South Africa (Altink, 1987), the final school results in South Africa become available only two or three weeks prior to the start of the new academic year programme (Jacobs, 2010). With more information about their own abilities, proficiency and preferences, students will be able to make better decisions and better advice can be given to students about better placement. This would enhance success and reduce attrition, argues Jacobs (2010). Coughlan (2006) explains that, if there is a great similarity between the educational experience and culture of a person at school and in the HE institution where he or she enrols, that person has a better chance of success at university. The fact that the final NSC results are available so close to the start of the new academic year is, has always had an impact on the SciMathUS programme as well. Students often only apply for the programme after their final Grade 12 results become available (Smit, 2011).

Research shows that, in order to implement sound assessment practices, it is better to have more than one measuring instrument and particularly in the light of the uncertainty about the predictive value of the Grade 12 results for so many students in South Africa, it is therefore important to use an additional measurement (Nel & Kistner, 2009; Maree, Pretorius, & Eiselen, 2003; Altink, 1987). The new South African HE law also requires that selection is done in a fair and transparent manner (Van der Flier, Thijs, & Zaaiman, 2003). Different measures such as a specific type of Pre Entry selection test by Altink (1987) have therefore been developed or are still being developed. When only a numbered of places are available for placement in specific programmes, as is also the case in SciMathUS, and when additional tests cannot easily be administered due to logistical and financial challenges, other selection options have to be considered. It is for this reason that the Stellenbosch University Access Test was considered as an alternative measurement tool by the programme.

2.8.2 Alternative admission tests

When administering tests, there should be certainty about what is being assessed. Achievement tests (traditional examinations) measure previously learnt content and achievement in academic skills, while aptitude tests measure ability and reasoning skills in a content-free environment (Altink, 1987 in both Zaaiman, 1999 and Rollnick, 2010). According to Murphy and Maree (2006) in Rollnick (2010), measuring potential is a process-orientated approach to assessment, whereas measuring ability and aptitude are product-orientated assessments. Yeld and Haeck (1997) cite Miller on potential, saying that "[w]hat is appealing about the term 'potential' as a name for an invisible target is that it refers to the

absence of something by affirming its presence" (p. 7). In other words, in order for something to be assessed, that something must exist: a test seeking to measure potential must therefore produce a performance of some kind and that performance is an indication of an individual's ability to produce the performance, not of potential to do so. The Alternative Admissions Research Project (AARP) developed at the University of Cape Town (UCT) with the aim of operating within this framework seeks to identify students whose school results do not adequately reflect their potential to succeed in university studies. It was used to provide additional access opportunities for students from disadvantaged educational backgrounds. The National Benchmark Test (NBT) was developed from these tests (University of Cape Town, 2012).

To be successful in HE, a student needs different combinations of skills, abilities and qualities (Rollnick, 2010; Altink, 1987). The behaviour of each individual is influenced by a number of interacting factors. This is discussed in more detail in the section on success.

Assessment of potential is complex (Maree, Pretorius, & Eiselen, 2003; Lowis & Castley, 2008; Cliffordson, 2008; Altink, 1987; Mabila, Malatje, Addo-Bediako, Kazini, & Mathabatha, 2006). Researchers have developed and assessed different measures, instruments and concepts to address these issues. The relationship between school results, university performance and the results of other assessment instruments or measures has been the interest of many researchers internationally for a number of years. Different criteria and measures other than Grade 12 marks have been widely investigated and debated to be used in selection for, admission/access into or predicting success or performance in tertiary institutions (access). Indicators of potential such as motivation, exposure to a commitment to learning, biographical descriptions of belief in self-efficacy and reasoning ability have all become part of what is assessed in deciding on granting access to university (Coughlan, 2006). Although these indicators are being used widely, the literature warns that these efforts have had mixed success, because academic achievement is complex. (Schunk & Pajares, 2005, p. 94). It is also expected that the greater the match between the predicting test and the kind of performance it should predict, the better the "predictive power for performance in the programme" (Zaaiman, 1998, p. 69).

Some of the measures that are used during selecting (sometimes in combination) are:

- achievement tests (traditional examinations) measure previously learnt content and achievement in academic skills – not sufficient if the quality of schooling varies as argued above;
- aptitude tests (i.e. SAT in America) measure abstract capabilities such as insight, comprehension and problem solving skills (Altink, 1987; Rollnick, 2010; Zaaiman,

1998) - accused of being culturally biased (Fleming and Garcia, 1998, in Rollnick, 2010);

- ability tests measure a person's ability or skill in a specific field. It is less influenced by previous educational stages (Dore, 1976; Drenth, 1977 cited by Altink (1987). On the other hand, precisely because they are less criterion specific, ability tests often show less validity in the prediction of the student's performance (especially short-term). Furthermore, abilities need time and opportunity to develop and to be visible in concrete scholastic achievement (Altink, 1987);
- skills tests measure basic competencies (Eiselen, Strauss, & Jonck, 2007) that are typically associated with essential work activities for a wide variety of jobs. They are designed to determine whether or not an individual has the requisite level of skill required to effectively perform at a job that will require the frequent use of the skills in question (Criteria Corporation, 2012);
- access tests to supplement school results in decisions regarding admission - conveying important information regarding the preparedness of prospective students for university, but not necessarily discriminating satisfactorily between potentially successful and unsuccessful students (Bothma, Botha, & Le Roux, 2004);
- dynamic assessment and assisted learning - apparently favouring students who initially had low scores more than students who initially had high scores. Dynamic assessment is also rather time-consuming and labour-intensive (Van der Flier, Thijs, & Zaaiman, 2003; Rollnick, 2010);
- demographic factors to increase understanding of how to identify potentially successful students in graduate programmes – also perceived as problematic because the validity of the measurement of these non-cognitive factors is questionable.. Once a standardised procedure for these factors is set, it could be used for selection though (Fastre, Gijselaers, & Segers, 2008); and
- personal interviews - often perceived as an 'inexact science', because during an interview, the interpretation of the information relies on the extensive experience of the people engaged with the selection and they are expensive to apply and impractical to implement (Rollnick, 2010, p. 84). On the other hand, Schwartz (2004) argues that; although a fair admissions system should always strive to use assessment methods that are reliable and valid, assessment can legitimately include 'hard' quantifiable measures and qualitative judgements.

Wagner-Welsh (2008) researched the different placements tests used by a number of universities internationally. Many other researchers also investigated the different selection procedures and tests used (Maree, Pretorius, & Eiselen, 2003; Koch, 2007; Morris, 2009; Zaaiman, Van Der Flier, & Thijs, 2000; Fernando, Prescott, Cleland, Greaves, & McKenzie, 2009).

In the USA the Advanced Placement (AP) programme serves an important role in college admission (Kuh, Kinzie, Schuh, & Whitt, 2005), while research in the UK indicates that A-level performance is by far the most common determinant of placement in HE (Scwartz 2003, cited in Rollnick, 2012, p. 74). On the other hand, Straw (2003, p. 37) also warns that the A-level system is not necessarily the best way to judge whether students would be successful in HE, while Klopfenstein and Thomas (2009) question the policy in the UK that preference is given to students with AP course experience in the university admissions process. According to them, there is no evidence that taking the AP course increases the prospects of success in college beyond the AP curriculum for the average student, regardless of race or family income. In spite of the assumption that students who have good Grade 12 results will do well in HE, Le Roux, Bothma and Botha (2004) indicate that universities in South Africa experience that students with good Grade 12 marks do not necessarily pass their first year without problems and that school results on average lead to unrealistically high expectations of performance at university.

In a Swedish study by Cliffordson (2008) the predictive validity of criterion- and norm-referenced grades and the Swedish Scholastic Aptitude Test (SweSAT) was investigated in an attempt to address the so-called achievement versus aptitude argument. The essence of this argument is that achievement tests are better predictors of academic success than aptitude tests. The results from this study however indicate that criterion-referenced grades have almost the same predictive validity as norm-referenced grades.

In 1997, the South African government introduced the Higher Education Act (Act No. 101 of 1997) to regulate HE. Among other things, the Act specifically allows HEIs to implement additional admissions criteria on condition that these criteria have to broaden, rather than restrict access (Van der Merwe & De Beer, 2006). Using additional admission tests alongside the NSC results for admission into HE could, however, also be perceived as expressing distrust in the school system. It also opens up the possibility that prospective students may be coached for these alternative tests.

The following tests are examples of alternative tests used by HEI in South Africa for selection and admission purposes: the Placement Test in English for Educational Purposes (PTEEP) and the Alternative Admissions Research Project (AARP) at the University of Cape Town (University of Cape Town, 2012), the Accuplacer computerised placement tests, used either for admission or development purposes depending on whether or not the students had met the matriculation admissions criteria for direct admission, used at the Nelson Mandela Metropolitan University (Wagner-Welsh, 2008) and the Access Tests (AT) of Stellenbosch University (Bothma, Botha, & Le Roux, 2004; Le Roux, Bothma, & Botha, 2004).

2.8.2.1 Access Tests (AT) of Stellenbosch University

The main goal of the AT is to determine whether applicants are adequately prepared for university studies with regard to generic language, numeracy and thinking skills, as well as curriculum-specific skills in Mathematics and Physical Sciences (Nel & Kistner, 2009). It was also used and to allow certain candidates who were not in possession of matriculation endorsement, but who showed potential to be successful at university, to enrol at SU. The AT has been used diagnostically in the context of academic development programmes at Stellenbosch University between 1995 and 2011. Initially it was also administered to provide additional information in view of the need for channelling students, for example, into extended degree programmes. Elements of the battery also provide some measure of potential (Bothma, Botha, & Le Roux, 2004; Nel & Kistner, 2009).

From 1998 to 2004 all applicants at SU with a Grade 12 aggregate average below 70% in Grade 11 or 12 had to complete the Access Test prior to admission (Nel & Kistner, 2009). After 2006 up to the end of 2011, all applicants to SU had to write the Access Tests prior to being admitted. Between 2008 and 2011, the combination of the AT and school results was used in a 40:60 ratio (where the AT aggregate counts 40% and the Grade 12 school aggregate counts 60%) as basic requirement for access to SU (Nel & Kistner, 2009). The Access Test consists of the following subtests: Language, Mathematics, Physical Sciences, Numeracy and Thinking skills. Prospective students wrote different combination of tests, depending on the degree programme they wanted to enrol in. For the sake of this study, only the Mathematics and Physical Sciences results were used. The results were used for research purposes only and were not used for placement at Stellenbosch University or SciMathUS.

In a study conducted by Bothma, Botha and Le Roux in 2004 to investigate the relationship between school marks, results in the Stellenbosch University Access Tests (AT) and first-year university performance, they found that the AT results gave a prospective student a more accurate indication of his/her expected average first-year performance at university. However, they also concluded that although the AT expressed important information about the preparedness of prospective students for university, “these tests do not discriminate satisfactorily between potentially successful and unsuccessful students” (Bothma, Botha, & Le Roux, 2004, p. 86). Nel and Kistner (2009) demonstrate that the Access Test is a meaningful predictor of university performance and that it accounts for 36,2% of the variance in first-year performance for the students included in their research.

As indicated before and discussed in section 2.8, there are more factors that have an influence on success. This assumption was also tested in this study.

2.8.2.2 The National Benchmark Test (NBT)

The National Benchmark Test (NBT) will replace the use of all the above-mentioned tests as all students wanting to enter HE in 2013, have to write the National Benchmark Test. (University of Cape Town, National Benchmark Tests, 2011). These NBT, developed under the supervision of Higher Education South Africa (HESA) reflects more than 10 years of research by different institutions of higher education across South Africa. The NBT was designed to measure the levels of proficiency in Academic Literacy, Quantitative Literacy and Mathematics as related to the demands of tertiary study of prospective first-year applicants into higher education. The NBT also provides information to assist in the placement of students in appropriate curricula routes (e.g. regular, augmented, extended, bridging or foundation programmes) and with the development of curriculum for HE programmes. In addition, this test assists the higher education sector to interpret the results obtained at the end of the secondary school phase. (Higher Education in South Africa (HESA), 2006; University of Cape Town, 2012).

2.8.2.3 Alternative tests considered by SciMathUS

SciMathUS considered using additional test results as part of its selection tool for a number of years. Before 2008, the AARP tests were administered to students who applied for the programme before a specific date. Since many students only applied for the programme after the final Grade 12 results became available, it was a challenge to administer, assess and interpret an additional test prior to admission. There was not enough time for that. Due to financial considerations (also for the applicants who had to travel to a specific venue where the tests were administered), as well as the fact that the test results could not be applied to all applicants, the use of these tests as a possible selection tool was discontinued.

Since the programme was still interested in finding a way to gather more information about its applicants, especially also if that tool could measure the potential of its applicants, the use of the Stellenbosch University Access Test (AT) was considered. The same biggest challenge experienced with the AARP tests, however, was also experienced with the AT; many students only applied for the programme after they received their final Grade 12 results. In the past, many students only realised that they did not meet the entry requirements for HE when they wanted to register for HE and then applied for SciMathUS. In was decided to continue administering the AT to the SciMathUS students. If it could not be used as a selection tool, it could provide additional information such as whether the students are adequately prepared for university studies. Elements of the battery also provide some measure of potential (Bothma, Botha, & Le Roux, 2004; Nel & Kistner, 2009). Since 2009, the AT is administered annually to the SciMathUS group twice; the first round within the first days of the programme and the second set towards the end of the bridging year. This is partly what motivated this investigation: to measure whether the AT of Stellenbosch University indeed measured the

preparedness of the students for university studies or their potential. One way to determine this, was to measure the performance in the AT against the performance in HE. It was therefore investigated with the NSC results as a possible measurement tool for the prediction of success in HE, especially for a group of students who first attended a bridging programme.

As argued above, selection tests should aim to find the best combination of practically measurable predictors for further performance. If they are used to select students who have had less opportunity to develop their potential capabilities, the tests should aim for maximal predictive validity and sufficient chances for students to succeed (Altink, 1987). This brings one to the issue of performance. What is performance and success?

2.9 Access for success

2.9.1 What is success?

Volumes of books have been published on how to promote student success; many more self-help guides exist promising the reader success. Although this is not a scientifically proven statement, it may be true that striving to be successful in life could be the most sought after goal of every person.

There are multiple definitions of the concept of success. Even dictionaries define it differently. Most commonly, student success is measured and determined quantitatively by pass and retention rates (Gibbon, 2009; Akoojee & Nkomo, 2007; Council on Higher Education (CHE), 2010; Kuh, Kinzie, Buckley, Bridges, & Hayek, 2006). According to the DHET (2012) and CHE (2010), student success rates are determined when full-time equivalent degree credits are divided by full-time equivalent enrolments. These calculations, for a programme or for an institution as a whole, produce weighted average success rates for a group of courses. Graduation rates are calculated by dividing the graduates of a given academic year by the head count enrolments of that year. These graduation rates function as indicators of what the throughput rates of cohorts of students are (Department of Higher Education and Training (DHET), 2012).

If success is perceived from Morrow's (epistemological access) perspective, however, where a learner has to learn how to become a participant in an academic practice (university) (Morrow, 2009), success is defined as what is achieved after the learner has become a successful participant in an academic practice. Astin (1999) adds to this that learning will occur when the learning environment is structured to encourage active participation by the student. He further explains how he perceives a student to become a successful and active participant in this practice.

The basic principle of Astin's theory of (student) involvement, first published in 1962, is that a student learns more (growth takes place, leading to success) the more he or she is involved in and dedicates a lot of energy to academics, spends time on campus, participates actively in student organisations and activities, interacts often with faculty members and other students and actively engages in his or her whole environment (Astin, 1993; Astin, 1999). The most important institutional resource, therefore, is student time and effort. The student therefore plays a vital role in determining his or her own degree of involvement (or amount of time and effort) in the different activities of the institute to be successful. “In other words, the theory of student involvement argues that a particular curriculum, to achieve the effects intended, must elicit sufficient student effort and investment of energy to bring about the desired learning and development” (Astin, 1999, p. 522).

This is echoed by Morrow (2009) who argues that academic achievement is judged by how well someone is engaged in an academic practice (Morrow’s word) or a discipline. Academic achievement (success) is accomplished by someone who understands a specific academic practice or discipline, can maintain that discipline and make a contribution towards the development of that discipline. To learn how to become a participant in an academic practice is a long-term process that involves learning and assistance by those who already understand that practice. Morrow calls this learning how to become a participant, ‘gaining access’ (Morrow, 2009, p. 77), epistemological access. Success, in other words implies epistemological access and true (epistemological) access occurs when someone has learned to become a master of an academic discipline. Educational achievement, on the other hand, is attained when someone, for instance, earns credits or a number of distinctions in a specific examination.

According to Tinto (2006-2007), the study (and business) of student retention (and success) is easily one of the most widely studied topics in HE, enriched by the inclusion of research on the experience of underrepresented and low-income students. In spite of 40 years of research, Tinto says, this work has not resulted in a solution to the problem. The reasons Tinto and Pusser (2006) give for this problem are the following:

- Too much of the research has the assumption that knowing why students leave is the same as knowing why students stay and succeed;
- Secondly, too much of the research focuses on theoretically appealing concepts without suggesting enough action to solve the problems – in spite of work done by himself and many others (Kuh, Kinzie, Schuh, & Whitt, 2005; Klopfenstein & Thomas, 2009; Negash, Olusola, & Colucci, 2011; Pascarella & Terenzini, 2005). Tinto and Pusser (2006) argue that many researchers know that the integration between social and academic issues is important for a student to succeed, but that

little is being done to address the issue (also refer to the discussions in sections 2.9 and 2.14.2);

- Thirdly, Tinto and Pusser (2006) feel that institutions focus too much in their research on events that are outside the institution's ability to change while the institution is unable to do anything about it. They refer to issues such as students' home circumstances and other personal issues;
- In the fourth instance, Tinto and Pusser (2006) argue that the conflicting definitions of success cause a unified action plan to be put in place to promote student persistence or success. Different definitions of success lead to different action plans. For instance, the plan of an institution wanting a student to graduate with the degree he or she started with in the minimum time will differ from the plan of an institution allowing a student to graduate regardless of how long it takes that student to finish the course.
- Finally, they argue that the reason why the problem of student success has not yet been resolved is because studies focus on different issues such as financial aid, campus climate, or induction programmes for new students. "The result is that we have been unable to provide institutions with a comprehensive model of action that would allow them to weigh the outcomes of different forms of action and plan accordingly" (Tinto & Pusser, 2006, pp. 4-5).

Another interesting way to look at success is from the perspective of employers of graduates. What is needed to be a successful employee? Griesel and Parker (2009) report the views and expectations of employers and their evaluation of the quality of graduates produced by South African higher education institutions. One of the concluding findings of this pilot study is that employers need thinking, responsive and intellectually well-grounded individuals who are flexible and can readily and easily adapt to new demands and challenges required in the workplace (Griesel & Parker, 2009). Students are not assessed on these attributes directly and when they graduate, they do not pass on the basis of these attributes. Yet they need these qualities to be successful in the workplace, according to this study. A similar study was conducted by (Letseka, Cosser, Breier, & Visser, 2010). Kuh, Kinzie, Buckley, Bridges and Hayek (2006) also suggest that the ultimate success of students is measured by post-college indicators. "Given the massive investments of public and private resources in building and sustaining postsecondary educational institutions, knowing how individual students and the larger society benefit is, perhaps, the most important barometers of the degree to which students succeed in college. (p. 9).

2.9.2 Defining success for this study

Since the focus of this study is to determine the success rate of students at the end of their first academic year, success is defined quantitatively. As will be discussed in Chapters Three and

Four, the initial success rate is determined when students' pre and post intervention results are compared. In the second set of analyses, success is defined as a pass at the end of the first year in HE. This is a very limited definition of success, as the end of the first year of study cannot be seen as being successful or not. It is also known, however, that many students drop out of HE at the end of their first year. Letseka (2009) reports that in 2005 the Department of Education (DoE) determined that an estimated 30% of the students who enrolled in 2000 for their first year of study dropped out of their studies by the end of the first year and 50% of them dropped out after three years without graduating. Only 22% of that cohort graduated within three years. Taking this into consideration, this current study will be followed up with a more comprehensive study to determine the success of the students who continued with their studies beyond their first year. These high dropout numbers also alert one to the need to investigate the factors impacting on success, as will be discussed in the next section.

2.9.3 Factors impacting on student performance or success

There is ample evidence in the literature that student performance is influenced by more than the ability of a student (Pascarella, Pierson, Wolniak, & Terenzini, 2004; Pascarella & Terenzini, 2005; Tinto & Pusser, 2006; Exner, 2003; Astin, 1999). The range or scope of these themes is vast enough that they can be studied on their own (and they are). In this study they are merely mentioned as also relevant.

Access and success are shaped by a range of contextual and personal factors that make the educational transformational agenda a challenging responsibility, especially in South Africa (Akoojee & Nkomo, 2007), where many students' backgrounds are not conducive to satisfactory performance. A number of these students are so-called first-generation students, the first in their families to attending post-school training. This is also a field of study on its own and much research has been done and is being done on this. It is, however, clear that first-generation students as a group have a more difficult transition from secondary school to college than their peers who are second- or third-generation students. "Not only do [these] students confront all the anxieties, dislocations and difficulties of any college student, their experiences often involve substantial cultural as well as social and academic transitions" (Pascarella, Pierson, Wolniak, & Terenzini, 2004, p. 250). The later investigations indicate that, compared to students whose parents are college graduates, first-generation students are more likely to discontinue their studies at the end of the first year, are less likely to remain enrolled in a four-year institution, finish a bachelor's degree after three years, and are less likely to remain enrolled to finish a bachelor's degree after five years.

Pascarella and Terenzini (1991 and 2005) cluster the research on what has been done about college student change into two broad categories: developmental theories, including sociological perspectives, and college impact models. According to them, the research of the past thirty years has focused on the "process of individual human growth" (1991, p. 17) -

psychological or developmental factors in the student and environmental or sociological factors such as effects between and within institutions. For the developmental theories, they further adopt the so called "four-family structure" (1991, p, 18) originated by Knefelkamp, Widick and Parker in 1978 and later modified by Rodgers in 1989:

- Psychosocial theories (viewing individual development as the accomplishment of a series of developmental tasks) but on a second level also deals with the formulation of identity (such as gender, race-ethnicity or sexual orientation);
- cognitive-structural theories (seeking to describe the nature and processes of change, concentrating on the epistemological structures that individuals construct to give meaning to their worlds);
- typological models (focusing on relatively stable differences among individuals and on differences in the ways individuals perceive the world or respond to it); and
- person-environmental interaction models, focusing in detail on the environment and how it influences behaviour through its interactions with characteristics of the individual.

It is, however, also important to bear in mind that some of these characteristics overlap and that some of the theories are complementary. The sociologically orientated models emphasise the context in which a student operates. The environment includes institutional factors and structures, but also the attitudes and behaviours of others who occupy and define this environment. The sociological models resemble the developmental models in the sense that students are active participants in the (change) process. Sociological models alone, however, do not emphasise the cognitive and emotional characteristics of students or the students' readiness for intellectual, academic and psychosocial change (Pascarella & Terenzini, 2005). According to Pascarella and Terenzini (2005), the literature on psychosocial theory builds on the work of Erikson. Even Erikson, who is known for his formulation of age-related, biological and psychological developmental stages, is of the view that the individual's environment shapes each individual's specific character.

Rollnick (2010) reports that different researchers in South Africa found conflicting correlations between background and performance. Taylor (2010) indicates that school circumstances have a bigger influence on performance than home circumstances while Schwartz (2004) reports that the effect of social background on attainment or success begins to appear by the age of two. Many school-going learners and students have responsibilities at home or at work, or interrupt their education for various reasons. This can affect their educational achievement. In the assessment of the factors that impact upon student learning and/or retention (performance is needed for retention) or success, the complexity of the issues involved is clear. It should also be emphasised that, in terms of the range of factors, there is interaction among them. When Tinto and Pusser (2006) makes us aware that there is no

unified action plan to promote student persistence or success, the question arises whether these factors can be understood and managed in such a way that one plan can address the complexity of the issue (Pokorny & Pokorny, 2005; Enslin, Button, Chakane, de Groot, & Dison, 2006; Letseka, 2009).

Research conducted at the Alternative Admissions Project at the University of Cape Town suggests that factors likely to affect success at university are "a complex blend of cognitive, affective, motivational, dispositional, socio-cultural, economic and institutional variables" (Cliff in Enslin, Button, Chakane, de Groot, & Dison (2006), p. 437). The primary purpose of the Biographical Questionnaire developed and used by the University of the Witwatersrand was to tap those abilities. According to Enslin, Button, Chakane, de Groot and Dison (2006) as well as Dweck (2010) possibly the most crucial factor influencing success is motivation.

According to a Council on Higher Education (CHE) study (2010), there are three approaches to studying factors that have an influence on academic achievement or success. This categorisation is also used for this study, but acknowledging its limitations and realising that these factors cannot be studied in isolation. The first approach describes academic performance on the basis of individual attributes of the student (individual attributes approach). The second approach offers explanations for student performance in social and cultural processes within the institution (institutional factors approach). The third is the more traditional statistical approach, as it measures student success in terms of a set of quantitative indicators (quantitative approach). A quantitative approach is unable to explain the low throughput, low graduation rate or even reasons for this, but it is useful to indicate trends. As will also be indicated in Chapter Three, where the methodology of this study is discussed, looking at success from a purely quantitative perspective is not possible. It does not do justice to reduce performance to a single number (Du Plessis & Gerber, 2012). According to Gephart (1988) in Gorard & Taylor (2004), even the stages of selecting variables in statistics are a "social enterprise" (p. 5-6). It is however only after a trend has been identified that reasons and/or action plans can be put in place to address the issue. These approaches will be discussed in brief below but also in Chapter Three.

2.9.3.1 Individual attributes approach

It is true that some students succeed beyond expectations, often because they have a drive to get out of circumstances. It is also known that some students do not perform in spite of being surrounded by all the resources in an encouraging environment (Tinto & Pusser, 2006).

Apart from looking at academic performance from only the student's cognitive ability perspective, there are other individual attributes to be taken into consideration. Pascarella and Terenzini (1991 and 2005) categorise the theories that take differences among individuals into consideration as typological models. The question arises why students who are exposed to

relatively the same 'circumstances', such as attending the same institution, being exposed to the same lecturers, etc. perform or develop differently. Typological models are interested in describing student change and development, and, although this is an important factor determining success, reviewing all the different theories about this issue is beyond the scope of this study.

In 1969 Chickering, who Pascarella and Terenizini (1991 and 2005) claim has had the most influence on the study of college impact on students, identified the following seven vectors of student development:

- achieving competence;
- managing emotions;
- becoming independent;
- developing mature interpersonal relationships;
- establishing identity;
- developing purpose; and
- developing integrity.

By implication this suggests that, after a student has developed all these features, they will be successful students. But Astin rightfully asks, "What is the impact of college attendance on students' personal, social and vocational development? Do they become more competent and knowledgeable?" (1993, p. 2). Astin's research includes assessment of students' cognitive development by using major American tests (individual attributes), extensive data on characteristics of institutions' general education programmes and how they teach, as well as measurements across institutions (Astin, 1993), again showing that the personal and institutional factors cannot be studied in isolation. Some researchers, however, do focus on more specific issues.

Dweck (2010) for instance, has done research about the mind-set of students. Together with others she has identified two sets of beliefs that people (and therefore students too) can have about their own intelligence. They either have a fixed mind-set, where there is a belief that intelligence is a static trait that one has, or there is a belief in a growth mind-set where intelligence can grow and be developed through effort and instruction. For people who have a fixed mind set, success is exceptionally important as it is a way to validate themselves, showing that they are clever and talented as well as that they are better than others. When students and their teachers however believe that intelligence is not fixed and that when students stretch themselves to learn something new, they perform better. Their efforts rather than their performance are praised. Success shows that they have mastered something, been stretched and learned new skills: it isn't seen as a demonstration of intelligence or talent.

What should also be taken into consideration when discussing student success or performance is the students' own attitude and self-belief. According to the social cognitive theory that underlies performance, individuals are agents, proactively engaged in their own development and are both viewed as products and producers of their own environments and social systems. "How people behave can often be better predicted by the beliefs they hold about their own capabilities than by what they are actually capable of accomplishing…" (Schunk & Pajares, 2005, p. 86). The self-belief determines how much effort that person is willing to put in, how long they will persevere and how much resilience they will be able to face when experiencing obstacles. In short, self-efficacy can affect a person's choice of activities, motivation and achievement outcomes (Dweck, 2006; Schunk & Pajares, 2005). This is confirmed by Evans (2000) and Thomas, Jones and & May (2010) reporting that academic preparedness, and, more particularly, learning strategies and locus of control, were identified as important in several studies.

The following list constitutes a summary of some of the individual factors mentioned by different researchers having an impact on success.

- The students' interest in the programme he or she is studying;
- his or her reading and/or writing skills;
- the academic preparedness;
- authentic (or intrinsic) motivation;
- taking responsibility for one's own learning process;
- being self-efficient;
- identifying one's own strengths and applying them;
- implementing strategies to achieve one's own set goals;
- having good learning styles and study habits;
- self-confidence;
- attending class;
- working hard and being conscientious;
- managing one's time;
- self-discipline;
- finding a balance between work and student life;
- race;
- gender;
- socio-economic status;
- family or parental occupation and/or education (or a lack thereof);
- level of parental involvement;

- level of comprehension of the language of instruction; and
- previous education and access to resources (Steenkamp, Baard, & Frick, 2009; Council on Higher Education (CHE), 2010; Schreiner & Hulme, 2009; Dirkx, 2001; Dweck, 2010; Kennet & Reed, 2009; Schunk & Pajares, 2005; Gibbon, 2009).

Kennet and Reed (2009) researched the psychosocial factors predicting performance and retention following a post-secondary success course in Canada. They used a model of self-control that gives an outline of why some people deal more effectively with upsets and, as a result, are more successful in attaining their goals than others. Exner (2003) reports on what he calls psycho-educational factors that inhibit first year student performance. This study was conducted with a large number of students attending eight courses at a university in the northern part of South Africa. According to this research, the fear of failure is the most problematic factor inhibiting student performance. The lack of accountability is the second biggest factor, followed by the lack of academic support, the process of selection to courses, inadequate career guidance and general anxiety, financial constraints, the lack of suitable study facilities, concentration and comprehension skills. It is confirmed by this study that these factors are interconnected and that they also have an impact on one another. When these challenges are therefore addressed, a holistic approach should be followed to enhance student success (Exner, 2003). Cosser and Sehlola (2009) also report on a South African study on the factors affecting the aspirations and preferences of students entering HE. After an initial base line study the students were asked (with given options though) why they performed better than expected. The following five factors scored the highest on a 5-point Likert scale:

- having a positive attitude towards life;
- being self-confident;
- interest in the programme being studied;
- wanting to prove themselves to those who thought they would not succeed; and
- knowing that the studies are paid for.

Kuh, Kinzie, Buckley, Bridges and Hayek (2006) quote Levine and Nidiffer who already in 1996 observed that the "primary weakness of both colleges for the poor and financial aid programs is their inability to help poor kids escape from the impoverished conditions in which they grow up" (p. 2). According to them the vast majority of poor young people can't even imagine going to college. By the time many of them are sixteen or seventeen years old, they have either already dropped out of school or they are educationally far behind their peers. Although this was said about the American situation, this is sadly also the case in South Africa and still very true sixteen years later.

It is also noteworthy that educationally disadvantaged students are not the only students at risk of not performing well. Astin (1985) reports that under-prepared students from socially

advantaged environments also experience problems in HE. Learning skills that are not developed leads to difficulty in comprehension, irrespective of why it developed or did not develop. When reading becomes a problem, the student becomes bored, discouraged, disengaged and will eventually drop out of the system. This is however also a topic to be researched on its own (and it is!). For the purpose of this study it is sufficient to acknowledge the importance of these factors.

According to Morrow (2009), success and access cannot be seen as separate entities. Success is what the learner does to gain access. Epistemological access is essentially dependent on what the learner does while learning to become a successful participant in an academic practise and where the learner has to have a certain kind of humility and respect for the practise for which he or she is trying to become a participant (Morrow, 2009). Whether it is called access or success, it is dependent on the person wanting to become successful or wanting to have access.

2.9.3.2 Institutional factors approach

According to Astin (1993), "few people will argue with the premise that attending college can have a profound effect on one's life" (p. 1). With respect to Astin, 'college' is translated to 'any educational institution', as what happens in secondary school most certainly also has a profound effect on a student's life. In this section, student performance in social and cultural processes within the institution; the degree of 'fit' between the university culture and the students' home and school culture, is discussed. It is also described as the "methodological individualist" or "social psychological approach" by the Council for Higher Education (Council on Higher Education (CHE), 2010).

Titles such as Astin's *Four critical years* (1977) *What matters in College* (1993), Tinto's *Leaving College: Rethinking the Causes and Cures of Student Attrition* (1987 and 1994), Pascarella and Terenzini's *How college affect students*, and the two sub-titles of the different editions, *Findings and insights from twenty years of research* (1991), and, *A third decade of research* (2005), Kuh, Kinzie, Schuh and Whitt's *Student Success in College* (2005) indicate the scope of research produced in this field. There are numerous other works by many others, also dating back many years, indicating that this is not a new issue.

Tinto's research in the field of student success in or departure from (not implying that these concepts two are opposites as Tinto warns), is done mostly about institutional factors. As he, and later he and Pusser points out, it is not to shift the responsibility away from the student, but if the institution does not understand that it has to provide a place where even the personal attributes of a student can flourish, recruiting the best students will not ensure a good pass rate and therefore successful students (Tinto & Pusser, 2006). Osborne (2003) spells it out even more when he says that the effectiveness of any educational policy or practice is directly

related to the capacity of that policy or practice to increase student involvement (Osborne M. , 2003). The warning by Tinto and Pusser (2006) about why the volume of research that has been produced about success is still unable to tell institutions what to do to help students stay and persist as discussed in section 2.13, should also be kept in mind here.

Increased institutional rates of student success do not arise by chance. They are the result of a series of intentional institutional actions, policies, and practices that are consistently applied over the long term. The only factor (or variable (so to speak)) that institutions can influence to increase student success, is a change in its institutional character. The question is to what extent institutions have changed and is willing to change to make this happen (Thomas, Jones, & May, 2010). Ironically, higher education staff members are the only teaching staff in education, from elementary school to university who have no teaching qualifications to teach their own students (Tinto & Pusser, 2006). In their research, Pascarella and Terenzini (2005) report that "across all studies with college-level samples, we estimate that students receiving instruction matched to their learning style gain an advantage of .91 of a standard deviation over their counterparts" who have not received "instruction accommodating their preferred learning style" (p. 623).

Kuh, Kinzie, Schuh and Whitt (2005) documented noteworthy institutional conditions of a number of institutions that are important for student development in postsecondary education. These are:

- a clear focused institutional mission;
- high standards for student performance;
- support to explore human differences and emerging dimensions of the self;
- emphasis on the early months and the first year of study;
- respect for diversity of talents;
- integration of prior learning and experience;
- on-going practise of learned skills;
- active learning;
- assessment and feedback;
- student collaboration;
- adequate time on task; and
- out-of-class contact with the faculty.

Institutional factors also relate to inputs such as how the transition between school-to-university is filled. In some cases, institutions start with this "joining in" (Kuh, Kinzie, Schuh, & Whitt, 2005, p. 111) or filling the gap process long before the student actually joins the institution. Institutions have programmes when prospective students visit the higher

education institution, “to imagine what being a student would be like” (Briggs, Clark, & Hall, 2012, p. 6) when they still attend secondary school. In the words of Harvey and Drew (2006) cited by Briggs, Clark and Hall (2012), ‘students adjust quicker if they learn the institutional “discourse” and feel they fit in’ (Briggs, Clark, & Hall, 2012, p. 6).

Other institutional factors (also on a pre-higher education level) mentioned by various researchers (Gibbon, 2009; Akoojee & Nkomo, 2007; CHE, 2006; Mabila, Malatje, Addo-Bediako, Kazini, & Mathabatha, 2006; Negash, Olusola, & Colucci, 2011; Pascarella & Terenzini, 2005 A; Rollnick, 2010; Ogunlana, 2010; CHE, 2006; Taylor E. W., 2010; Osborne M., 2003; Evans, 2000) are summarised below:

- classroom environment;
- pupil teacher ratio;
- class size;
- the accessibility of staff;
- interaction with staff;
- teaching experience of the staff;
- the quality of tuition;
- problems regarding the implementation of education policies;
- the pedagogic distance between lecturer and student;
- a lack of qualified teachers or teaching facilities;
- inadequate transfer of relevant skills;
- language of instruction;
- the way information is disseminated;
- whether the students are day students or staying in residences on the campus;
- traveling arrangements between home and campus, including parking for commuting students;
- the power of a residence culture;
- the social integration (or lack there-of) of students;
- how accessible information is for the students;
- how easy or difficult it is for a student to navigate his or her way through a complex academic organisation;
- students' positive and/or negative experiences of the institution;
- whether an appropriate and relevant curriculum is in place how accessible the curriculum is as well as how the curriculum is delivered;
- fruitful student support mechanisms;
- appropriate assessment techniques;

- whether there is a balance between different teaching and learning situations (i.e. lecturers, tutorials, lab work) as well as the way feedback and comments on assignments are given to students, if given at all;
- textbooks and affordability of resources like textbooks;
- availability and accessibility of other facilities;
- administrative and financial structures;
- the culture of the institution;
- politics in the classroom and on campus;
- academic and financial support; and
- tuition fees. It is been mentioned repeatedly that too high fees (could) keep disadvantaged students away in the first place. It also causes stress while the students are studying if they know that they will not be able to pay the fees. Students can then not concentrate on their studies and therefore underperform.

According to Tinto and Pusser (2006), research on conditions needed within institution to promote student success points to the following. They describe this as "building educational communities that involve all students" (p. 8):

- institutional commitment, implying that there is a willingness of the institution to invest resources and provide the incentives and rewards needed by students to succeed;
- high expectations of all its students combined with good and timely advice about courses, majors, etc.;
- academic support (such as developmental education courses, tutoring, study groups, or supplemental instruction), social support (counselling, mentoring, and centres of support for students who might feel themselves out of place in a setting where they are a distinct minority) and financial support; and
- frequent and useful feedback about performance, and involvement or engagement, or what has also been described as academic and social integration as early as possible in the first year of study.

There is no doubt that the history and the contextual realities of a university or HEI influence students' academic performance. Institutional resources, cultures, internal politics, everyday academic practices and the particular ways in which the institutions interpret and respond to the broader societal challenges have an influence on students' chances of academic success (Council on Higher Education, (CHE), 2010). The challenge of turning the increased access (for participation) into (access for) success requires substantial up-front investment in curriculum design and materials development (Department of Higher Education and Training

(DHET), 2012). Transformation requires that the character of HEIs needs to be replaced with a democratic culture (Akoojee & Nkomo, 2007).

The problems of access, retention, success and throughput are by no means clearly defined or easy to solve. From the point of view of the monitoring of institutions' efficiency, it is also difficult to produce simple measures for throughput. Although all these factors are important (both student and institutional), it appears that the institution-related factors carry greater weight, not only in terms of directly influencing retention but also indirectly in enhancing the student-related factors (Negash, Olusola, & Colucci, 2011).

In Pascarella and Terenzini (1991 and 2005), Tinto's theory is called a 'Theory of student departure'. Tinto theorises that students enter HE with varying patterns of personal, family and academic characteristics and skills. This includes initial ideas and intentions about attendance and personal goals. These goals and commitments are modified and reformulated continuously through the interaction between the individual student and the specifi structures, including its academic and social members. Satisfying and rewarding encounters between the student and these members lead to better integration and therefore better retention and subsequent success. Students are more likely to succeed in their learning when they find themselves in settings that are committed to their success, have high expectations of them, provide needed academic and social support, provide frequent feedback, and actively involve them, especially with other students. "The key concept is that of educational community and the capacity of institutions to establish educational communities that involve all students as equal members" (Tinto & Pusser, 2006, p. 8).

When Tinto and Pusser (2006) discuss their Model of Institutional Action, they argue that student learning should be central to student success and that without learning, students are not successful regardless of whether or not they persist. "The more students learn and value their learning, the more likely they are to stay and graduate" (p. 8). In this model, they further argue, that institutional commitment to student success sets the tone for the climate for success that students encounter in their everyday interactions with the institution. Institutions influence the quality of student effort and student learning and in turn shape student success, particularly in the classroom. Success in the classroom generates credit and degree-credit progress and eventual degree completion. Success in the classroom in turn suggests faculty development.

According to Tinto and Pusser (2006), institutions should implement teaching especially large first-year classes through cooperative and/or collaborative learning and problem-based learning pedagogies, so called pedagogies of engagement. In their research they cite a number of other researchers (Blumberg, 2000; Cooper & Robinson, 1995; Springer, Stanne, & Donovan, 1999; Wilkerson & Gijselaers, 1996) confirming that participating students, actively engaged in learning with others promote social involvement. These pedagogies of

engagement significantly enhance students' processing skills without diminishing content acquisition. Better processing skills lead to persistence and ultimately to success. The teaching philosophy of SciMathUS is a problem-based learning approach which also promotes self-directed learning. The students' results have improved by more than 15 percentage points on average over the past 11 years (see Chapter Four, section 4.4.1) The practical experience gained in this programme therefore confirms the research. Students can be and are successful when they are engaged in their own learning.

Although Morrow (2009) gives the responsibility of gaining epistemological access to the student to become part of the learning process, he has something to say about the institution as well. He for instance says that "It was not students who failed Bantu Education, but Bantu Education that failed students" (p 71). The teacher (representing the institution) is an important stake holder in the learning process as they have the responsibility to guide the learners to keep on the right track. Teachers who are reluctant to be critical about the efforts made by the learners or who simplify the practice of which the learners are trying to gain access, are not fulfilling their role as teachers. They also have to let the learners face the challenges of learning and have to respect the efforts made by the learners during that process of achieving epistemological access.

While an effort was made to distinguish between students' own attributes and institutional factors as separate factors having an effect on the success of students, it is clear from the arguments of the different authors studied, that these factors cannot really be separated. In the framework for student success proposed by Kuh, Kinzie, Buckley, Bridges and Hayek, (2006), the first component that they mention represents students' precollege experiences: academic preparation, family background, enrolment choices and financial aid and assistance policies. The next component towards success they label as the college experience itself, including two central features: students' behaviour and institutional conditions. At the intersection of student behaviour and institutional conditions they put the student and his or her engagement (Kuh, Kinzie, Buckley, Bridges, & Hayek, 2006). As Morrow (2009) also argues, teaching is only successful if learners and teachers see it as a co-operative task between themselves and the institution and where learners can develop proper self-understanding. "Teaching presupposes that the teachers and the learners share an interest in an academic practise that is not 'owned' by anyone" (Morrow, 2009, p. 81).

In the literature, the institution generally refers to the academic institution. Looking at the bigger picture, however, society should be seen as part of the institution and the institution part of the society in which the student lives and operates. Students enter HE from different backgrounds and academic positions. South African students often do so from extreme positions of inequality; most obviously because of the difference in schooling, or as Taylor (2010) and Spaull (2012) describe it - a country with (still) basically two education systems.

A lack of academic preparedness, both in terms of social class and the kind of school attended is cited as the reason why South African students fail to or take longer to master degree requirements (Council on Higher Education (CHE), 2010; Scott I. , 2009; Rollnick, 2010; Kuh, Kinzie, Schuh, & Whitt, 2005; Cosser & Sehlola, 2009). A lack of finances forces many students to work while they study (often during the night!) or to postpone their studies for a year or two because they have to work full time to fund their own studies (Smit, 2011). These non-academic institution factors however also have a huge influence on the throughput figures of students and for that matter on the success rate of higher education institutions themselves.

2.9.3.3 Statistical approach

Student learning is central to the mission of HEIs. However, when institutions' success rate is measured, grade points and eventually how many students graduate are mainly used to measure the success rate of that institution and, subsequently, that determines the subsidies earned by that HEI[9] (Gibbon, 2009; Akoojee & Nkomo, 2007; CHE, 2006; Kuh, Kinzie, Buckley, Bridges, & Hayek, 2006). HE is expensive, for both the student and the institution and therefore assessing how many of the students who enrol eventually graduate, is necessary. That is, however, a limited way of determining success.

Graduation rates are usually calculated by dividing the total number of qualifications awarded at an institution by the total number of students enrolled. This gives a rough measure of the number of years that graduates are staying in the system, but does not take into account the reasons for inconsistent enrolments or the different durations of degree programmes (Council on Higher Education (CHE), 2010). Students may further complete one year of a course at one institution and finish at a different institution; a 'drop out' at one place may mean a 'drop in' elsewhere. Although the 'losing' institution may perceive these students as failures, they are in fact not failures if they do graduate somewhere else (Smit, 2011) If the circumstances mentioned above are not taken into consideration, pure quantitative studies reveal a skewed picture.

According to Scott, Yeld and Hendry (2007) only half of all first-year students who registered at all the contact universities in South Africa in 2000 graduated within five years while 38% of that cohort left without graduating at all. The Student Pathways study by the Human Sciences Research Council also found that on average only 15% of students finish their degrees in the allotted time (Letseka, 2009). Despite the limitations of quantitative studies failing to reflect the intricacies of social conditions and unable to explain the reasons for i.e. low graduation rates, they are useful indicators of trends that need to be investigated more deeply and systematically.

[9] The rating of the researchers and their research outputs are also taken into consideration.

Pascarella and Terenzini (1991), who analysed longitudinal data from 18 four-year colleges in the USA, indicate that there are too many problems regarding the reliability and validity of grade point average to consider it solely or perhaps even primarily as a measure of how much was learned while a student attended HE. Although grades do reflect learning, and may well be the most readily available measure to do so, it is also clear that grades or scores are influenced by many other factors. The difference in courses taken, the amount of work assessed, the way the content is offered and assessed are only some of the factors that makes it difficult to make standardised comparisons of learning based on student scores. When measuring students' critical thinking and reasoning skills, for instance, it is not surprising that students who study social sciences outperform all the others – they are exposed to that during their studies much more than students following a more exact sciences course. It is also quite possible that, irrespective of academic ability, the pattern and sequence of courses taken by students may influence not only their scores in the specific subject matter, but also more cognitive abilities (Pascarella & Terenzini, 2005).

Tinto and Pusser (2006) add to this debate that much of the research and theoretical work on student persistence or success has been performed in isolation, with different areas of work not necessarily knowing what the others are doing. While some studies focus on issues of financial aid, others on campus climate, and others still on programming seminars for specific groups. These issues are not reflected in statistics. The result is that little has been done to shed light on the practical question of how state actions can enhance the capacity of institutions to promote student persistence or success.

Looking at the above-mentioned factors as separate entities could also lead to a perception that there are no connections between them and that they can be fixed in isolation. This is not possible, as Tinto and Pusser (2006) clearly indicate when they say that "the model [of institutional action for student success] argues that student success is most likely to occur when all [the above] conditions exist" (p, 10).

The choice to analyse the results of the students in this study only quantitatively, especially after arguing for a multivariate approach towards success in this chapter, may rightly be questioned. To determine the success of any student by only determining his or her pass rate has no educational grounds. To do only a statistical approach in this study was a pure pragmatic choice. I am fully aware of its limitations, but as explained, this is a first step towards analysing the performance of former SciMathUS students in HE. This will be followed up by a more comprehensive qualitative study. The reasons for the students' successes and failures have to be investigated to get a full picture of their success. This is also discussed in the following chapter.

2.10 Conclusion

The research question of this study was to determine whether Grade 12 results and university access test results could predict success in HE for students who first attended a bridging programme. Apart from finding answers through statistical analyses (and reported on in Chapter Four), theoretical themes and constructs were studied that could inform and frame the answers to this question.

In the introduction of this chapter, some changes in society were discussed to explain the context and need for more people entering HE. The knowledge-economy needs multi-skilled people embarking on a lifelong-learning journey. As this research is about a bridging programme offered in South Africa, a discussion of the education system in this country provides a backdrop to bridging programmes. There are different kinds of access programmes. These were also discussed. Understandably the SciMathUS bridging programme, the programme under investigation in this research, had to be introduced.

Except for the expectations of the institution, a student who enters HE also wants to be successful and obtain a degree. Since this study was interested in the success of students in HE, it was required to study what success is. This led to the discussion of factors that might influence a student's success.

Morrow's argument, amongst others, about epistemological access seems an appropriate way to conclude the theoretical constructs and themes centred around access and success. Morrow (2009) claims that access is not a product, it cannot be supplied, bought or stolen. Neither can it be delivered, given or transmitted to a student, whether he or she can afford to pay the tuition fees or study with a bursary. Epistemological access is learning how to become a successful participant in academic practice. There are many dimensions to the success or increased success as argued by researchers such as Astin (1999), Exner (2003), Pascarella, Pierson, Wolniak and Terenzini (2004), Kuh, Kinzie, Schuh and Whitt (2005), Pascarella and Terenzini (2005) and Tinto and Pusser (2006). The student has to have particular characteristics and a certain level of mental health, talent, access to enough resources (such as finances, facilities and books), and be in the company of other serious students. Positive institutional conditions; good facilities; the sympathetic support and assistance of good teachers; and good resources are also important. "But all of these things can, at best, only facilitate, and never *guarantee* my epistemological access; I must be *trying* to learn. It is essentially dependent on what I *do* (emphasis in original) (Morrow, 2009, p. 78).

The next chapter deals with the research methodology applied in this study.

3 CHAPTER THREE

3.1 Introduction

In order to answer the research question of this study and to measure the impact of selected variables on student success in HE, an empirical investigation was conducted. This investigation required that the students' results before and after attending the SciMathUS bridging programme had to be analysed. Before the students' results at the end of their first year could be determined, it was necessary to calculate how many of the students who attended the programme, qualified to register for and indeed enrolled in HE. After that, the students' first year results were analysed. Only then was it possible to find out whether there was a correlation between their improved Grade 12 results and their performance in HE at the end of their first year. Statistics were used to determine the pass rates of the students and to correlate the Grade 12 results with the end of their first year results. Although quantitative, this study is also embedded in a rounded view of research as comprising quantitative and qualitative components. The argument against the strict distinction between quantitative and qualitative research is therefore also presented in this chapter.

In the following sections of this chapter, the design and methods used for the empirical investigation, who the participants were and how they were selected, are described. After indicating the variables that were chosen to measure the success of the students in higher education, a description follows of how the data were analysed. The instruments and procedures used for these analyses, the ethical considerations applied in this study are described before the chapter concludes with a summary.

3.2 Research paradigm

A research paradigm refers to the accepted tradition or framework that guides research. A paradigm further informs or guides the nature of the research as well as the decisions the researcher brings to the study. It describes everything that the research holds; its laws, beliefs, procedures, methods, the analysis as well as the interpretation of the data (Creswell, 2009; Gorard & Taylor, 2004; Babbie & Mouton, 2011; Mertens, 2005).

According to Creswell (2009), Ryan (2006) and Gorard (2010), 'number' or quantitative research, of which this specific study is also an example, is associated with testing objective theories, examining patterns, investigating relationships between variables that can be measured with instruments and analysed statistically. The paradigm associated with a quantitative study is in line with experimental or empirical scientific research where the answer or conclusion usually lies in a number and the interpretation thereof only. As described at the end of Chapter Two, to do only a statistical analysis of the students' performance was a pragmatic but very necessary choice. Only once counting the credits was

done and trends of how many students passed and failed were identified, the reasons for their success and failures can be investigated in more detail. Ryan's (2006) statement that a quantitative study is often used as a starting point for a qualitative study is very appropriate for this study. A study including the qualitative elements of success will have to follow this quantitative study.

Quantitative research is traditionally supported by positivist principles where the researcher uses a quantitatively orientated methodology and experiments to verify his or her hypothesis, as was done in this study. The aim of doing research from a quantitative perspective is further usually to build models and theories. These theories allow scientists to make sense of the world by providing positive statements about those aspects of the world that can be reduced to numbers and counted in some way. Such models and theories spell out the main variables of interest, integrate them into frameworks and provide guidance for intervention. The aim of this study was to determine whether a 'model could be built' to predict the success of students in HE. Positivism emphasizes that the only authentic knowledge is that which allows positive verification. It assumes an objective world and seeks to predict and explain casual relationships amongst the variables investigated (Lincoln, Lynham, & Guba, 2011; Ryan, 2006; Gephart, 1999). The focus of this study was to identify, quantify and measure variables to predict possible success of students in higher education. Variables were further manipulated to determine the possible relationships between them and their single or combined relations on student success.

Although this is a quantitative study, it would be short-sighted not to admit the limitations associated with this paradigm. The assumption in a positivist approach is that there is only one reality and positivist researchers claim that their findings are objective and true. Knowledge, however, cannot be separated from ontology and personal experiences. In spite of the importance of procedures and methods, research subjects cannot be seen as sources of information only; they should always be treated ethically. From an epistemological perspective, the researcher has to understand that he or she brings certain assumptions to the research. There is no neutral knowledge (Ryan, 2006). Another shortcoming of quantitative research concerning this study is that it excludes context, meaning and interpretation of the data. By comparing the first year results between the SciMathUS students and their peers from the same schools, but who did not attend the bridging programme first, was a way to create a context for the interpretation of the results in this study. By just analysing students' results without knowing how the students performed in comparison with others, does not mean much. Furthermore, the arguments of the researchers put forward in Chapter Two provide the background or context against which access and success should be interpreted ultimately.

The paradigm–method fit issue has inspired considerable debate. Lincoln and Guba (2011) acknowledge that substantial changes have occurred in the fifteen years since they first

published their categorisation of research paradigms in 1994. According to them and their colleague Lynham, the different paradigms are beginning to "interbreed" (Lincoln, Lynham, & Guba, 2011, p. 97). This correlates with similar ideas of Newman and Betz (1998), Gorard and Taylor (2004) and Gorard (2010) who argue that research can be more convincing when quantitative and qualitative approaches are used together. Cresswell (2009) also have a more inclusive approach and argue that qualitative and quantitative approaches to research should not be seen as polar opposites but as ends on a continuum. Gorard (2001) further argues that to a certain extent, all research deal with qualities, even when the observed qualities are counted. Similarly, when the words "some", "all" and "a few" are used, some form of number is implied.

Using a combination of methods is therefore more appropriate to discuss the issue of success. This involves different sets of philosophical assumptions. It is more than collecting and analysing the data in either a quantitative or a qualitative way. "It involves approaches in tandem so that the overall strength of the research is greater than each of the different approaches" (Creswell, 2009, p. 4). In 2011 Creswell (2011) confirms that a mixed method study may begin with a phase reflecting a specific "[post-positivist] leaning" but that the researcher may shift to a different ["constructivist] paradigm" (p. 275) in a next phase. This will also be the case if this study is to be taken further. This specific study would be the first quantitative part where the data is analysed to determine the pass rate of the students, determine the trend of how many enrolled in HE as well as analyse how they performed. The second part will be to analyse the reasons for the performance (or no performance) qualitatively. The choice of the method(s) used should therefore be determined by the needs of the investigation and not by the preferences and/or fears of the researcher. Using different methods can have the same research aim and the same overall rules of logic (Gorard & Taylor, 2004).

3.3 Research question and context

The research question of this study was to determine whether Grade 12 results and Access Test (AT) results could predict success in HE for students who first attended a bridging programme. In general, high Grade 12 results is perceived to be a good predictor of success in HE because "a student needs to have some mastery of knowledge and skills offered in previous education to be able to profit from subsequent education" (Altink, 1987, p. 2). However, if the quality of schooling varies considerably, like in South Africa, the use of these results, and especially as the only set of results for the purpose of selection, evaluation or prediction of success is questioned and researched as discussed in section 2.8.2 (Rollnick, 2010; Du Plessis & Gerber, 2012; Botha, McCrindle, & Owen, 2003; Schöer, Ntuli, Rankin, Sebastiao, & Hunt, 2010; Maree, Pretorius, & Eiselen, 2003; Potgieter, Davidowitz, & Venter, 2010; Griesel, 2003; Zaaiman, 1998) to mention a few.

The aim of the SciMathUS programme is to allow educationally disadvantaged students whose Grade 12 Mathematics and Physical Sciences results are below the standard entrance scores for admittance to HE, a second opportunity to improve their scores in these subjects and then reapply for HE (see section 2.6 for more detail). The assumption was therefore that, if the students who attend SciMathUS manage to increase their scores in the core subjects to a level to gain access into HE, their new improved Grade 12 results would predict their performance in HE. Since it is argued that Grade 12 results cannot be used as the only measurement for selection and should probably not be used as the only predictor of academic success in HE (Griesel, 1999, updated 2000; Griesel, 2003; Altink, 1987), Stellenbosch University AT was used as a second measurement tool in this regard. This was discussed in more detail in sections 2.8.2.1 and 2.8.2.3).

3.4 Research design and methodology

While the research paradigm informs the research process, the research design refers to the plan and procedures followed to address the research problem or question (Lincoln, Lynham, & Guba, 2011; Babbie & Mouton, 2011). The research method followed for a specific research is directly connected to the problem statement and research question. Quantitative methods are usually linked to a positivist methodology (Mertens, 2005; Gorard, 2001; Ryan, 2006) and associated with an approach to operationalise, measure, undertake quasi-experimentation, quantify, determine causality and correlations and to generalise results. A quantitative approach further aims at claiming truth by means of collecting evidence in an objective manner to confirm or falsify the claim (Mertens, 2005; Neuman, 2000; Lincoln, Lynham, & Guba, 2011).

Quantitative studies are divided into two main categories, i.e. empirical and non-empirical studies. Empirical studies make use of primary data (collected by the researcher self) or secondary data (data that already exist), although the distinction between the two can sometimes be blurred when, for instance data collected for a pilot study is used again later (Gorard, 2001). Data can furthermore be classified into two categories: numeric data and textual data. Each set of data has different characteristics and provide different kinds of information (Babbie & Mouton, 2011). As the present study used data that already exists (students' results), it can be classified as an empirical study making use of secondary numerical data.

In the empirical investigation, the aim was to determine whether there was a correlation between specific variables (that could possibly also predict success). By determining the number of students who successfully passed their first year, quantitative methods were employed to obtain the desired knowledge (methodology), as described by Mertens (2005). Various analyses were done in this study "to seek scientific discovery" (Lincoln, Lynham, & Guba, 2011, p. 104) and to get as close as possible to the reality (see section 3.6). The data

from SciMathUS, the Science and Mathematics bridging programme at Stellenbosch University (SU), as well as the first year results and the Access Test results were captured in MS Excel and MS Access.

Different statistical programmes were used to determine the (possible) relationships between the different data sets (see section 3.6).

3.4.1 Participants, selection criteria and context

The 'participants'[10] in this study are represented by their results only. No student was directly involved in a manner that allows an individual student to be identified. The results that were analysed in this study can be divided into two sets of results: the pre HE results of students who attended SciMathUS from 2008-2011 and the HE results of the students who attended SciMathUS obtained and enrolled at Stellenbosch University (SU) in 2009, 2010 and 2011.

The first class of SciMathUS consisted of 40 students in 2001. The number of students grew steadily to the approximately 100 students who have been selected to attend SciMathUS annually since 2008. The number of students to be accommodated in the programme, is dependent on the funding received by the programme (Smit, 2011). Details about the programme, and the subjects offered in the programme were discussed in detail in section 2.6. The entry requirements for SciMathUS are the following.

Students who wish to be considered for the programme:

- have to be in Grade 12 during the year of application or have matriculated the previous year;
- have to offer at least four subjects from the group of subjects designated for university admission[11]*
- should have a NSC average of at least 55% (excluding Life Orientation);
- should have a minimum of 50% in Afrikaans or English (Home Language or First Additional Language);
- for the Science stream, should have a minimum of either 30% in Mathematics or 80% in Mathematical Literacy and 30% in Physical Sciences;
- for the Accountancy stream, should have a minimum of either 30% in Mathematics or 80% in Mathematical Literacy;

[10] In this section the term 'student(s)' actually means 'student results' as the data were used anonymously. The student numbers were used initially to link the data of each student from the different systems. No names were used; no distinction was made between male and female, language group and population groups either– all the data were used as data only.

[11] Accounting, Agricultural Sciences, Business Studies, Consumer Studies, Dramatic Arts, Economics, Engineering Graphics and Design, Geography, History, Information Technology, Languages (one language of learning and teaching at a higher education institution and two other recognised language subjects), Life Sciences, Mathematics, Mathematical Literacy, Music, Physical Sciences, Religion Studies and Visual Arts

- submit evidence that they have been educationally disadvantaged, either financially, by school and/or home circumstances; and
- write an essay, motivating why they should be allowed in the programme, prove that he or she is highly motivated, hard-working and has a genuine ambition to obtain a university education (Smit, 2011).

As described in section 2.5.3.2, a new curriculum was implemented in South Africa. As a consequence, school leavers write a different exit examination since 2008. The students who attended SciMathUS in 2008 wrote the 'old curriculum' examination at the end of 2007 prior to entering SciMathUS and the new National Senior Certificate examination at the end of 2008, the year after attending SciMathUS. In the analysis of the pre and post intervention results in Mathematics and Physical Sciences, however, the 2008 intake's results were included. As described in section 2.6, the Accounting curriculum in SciMathUS is offered and assessed by Stellenbosch University. The pre and post intervention results in Accounting can therefore not be compared and were not used in this study. The choice of years is also explained in Chapter Four where the analyses of each set of results are discussed.

The context, in which this study is performed, is SciMathUS, a bridging programme. The programme is discussed in detail in section 2.6.

3.4.2 Collecting, organising and preparing the data for analysis

To determine the difference between the pre and post intervention results, NSC Mathematics and Physical Sciences as well as Stellenbosch University Access test results were analysed.

The results of the 2008-2011 intakes in SciMathUS were used in this study. Different numbers of students took Mathematics than Physical Sciences and therefore the number of results differs per analysis. The number of participants included in each analysis was indicated where appropriate and where the analyses were discussed in Chapter Four.

The population therefore also formed the sample in this case (Gorard, 2001) The 179 students from these three cohorts who enrolled at Stellenbosch University after completing SciMathUS formed the sample when the relationship between NSC and Access test results was determined. This sample makes up 75% of the total population of students from SciMathUS. The sample was the maximum size as the other 25% of students who enrolled at other institutions were omitted from the study.

The total number of students registered at Stellenbosch University for their first year during 2009-2011 was 15 039. After the data were screened for inconsistencies, outliers were omitted. A total of 1724 students from the same schools as the SciMathUS students enrolled at Stellenbosch University. The number of students (SciMathUS students included) representing these schools is 13% of the total number of first year students for these three

cohorts. The number of students who attended SciMathUS represents 10% of these 1724 students and 1% of the total population of first years, also for these cohorts. The SciMathUS students' results were only compared to the results of their peer group from the same schools and not to the whole group of first years.

Three sets of data of three cohorts of students who attended SciMathUS were used for this study.

- Two sets of the Grade 12 Mathematics and Physical Sciences results of four cohorts of students were analysed. One set of results were obtained at the end of the students' Grade 12 year in school, defined as the pre-intervention set of results. The second set of Grade 12 Mathematics and Physical Sciences results were obtained by the students after completing SciMathUS and after re-writing the Grade 12 NSC exams in these two subjects, defined as the post-intervention set of results.
- Two sets of Stellenbosch University Access Test results were analysed. One set of results were obtained at the beginning of the SciMathUS year (after the students have been admitted, defined as the pre-intervention set of Access Test results. The second set Access Test results were obtained towards the end of the SciMathUS year, defined as the post-intervention set of Access Test results. The same combinations of tests were used. The Stellenbosch University Access Tests were used by SciMathUS and included in this investigation because it provides a validated examination of scholastic proficiency independent from school performance additional to the NSC.
- The results obtained by the students at the end of the first year in HE at Stellenbosch University were the aggregate obtained by each student, irrespective of the degree programme they were enrolled in at Stellenbosch University.

All the data were collated in one Excell spread sheet: the students' pre and post intervention results in Mathematics and Physical Sciences, their AT scores in Mathematics and Physical Sciences and the average obtained at the end of their first year in HE at Stellenbosch University. The student numbers were used as the identifier.

3.4.3 Indicator of success for the empirical investigation

For the empirical investigation of this study, success was defined as the success at the end of the first year of study in HE. Initially the plan was to classify success into different success categories, but different reasons changed this. When the data were analysed it became clear that the students enrolled in 40 different degree programmes. Not all programmes have the same number of modules. Some of the students enrolled in extended degree programmes. This means that the students have not all registered for the same number of modules. This made it difficult to compare the results and the subgroups became too small. At the time of this study, most of the faculties at Stellenbosch University allow students to continue with

their studies to the next year or module when they have passed one third of their first year. Since the number of former SciMathUS students in this study who enrolled at Stellenbosch University was relatively small (n=179), it was decided to use the average of the students at the end of their first year and not subdivide the group into even smaller groups. The score used reflects the average obtained by each student, irrespective of how many modules that student registered for.

It was further decided to compare the students from SciMathUS with only their peer students from the same schools and the same programmes who enrolled at Stellenbosch University directly after school but who did not attend SciMathUS. This choice was made to achieve some homogeneity. Homogeneity reduces variance and it is important in empirical research that the samples have more or less the same characteristics (Black, 1999). The characteristics that were of particular interest in this case were that the students should have attended the same type of school in the same kind of circumstances and should have received the same type of teaching while at school. To compare the performance of the former SciMathUS students with the performance of the entire first-year cohort of students at Stellenbosch University would not be appropriate. The sample of the former SciMathUS students was too small to be compared to more than 15 000 fellow students. There was also too big a variety of schooling attended by all the first year students.

The National Norms and Standards for School Funding (NNSSF) implemented a policy to determine the amount of funding received by the Department of Basic Education for individual schools according to their poverty score (Department of Education, 1998). This poverty score assigns a school to a quintile rank (Q1 to Q5). In a HSRC study conducted by Chutgar and Kanjee (2009), they argue that the current quintile ranking system does not work effectively as this approach does not cater for the diverse nature of households and the composition of the school's learners. Although this system is being criticised, it is the only official system currently in use. This is also discussed in more detail in Chapter Four, section 4.2.

3.5 Statistical analysis

For the comparison of the pre and post-intervention analyses, a mixed model repeated measures ANOVA was conducted with time (pre and post), year as fixed effects and the students as random effect. The time-year interaction effect was tested as part of this analysis which tested whether the change in results from prior to the intervention to after the intervention were the same for all the years (2008-2011) indicated in this study. Relationships between different sets of results were tested, using Pearson correlations.

In the comparisons of SciMathUS students with their peers from the same schools and enrolled in the same faculties, a two-way ANOVA with group and faculty as the two factors

were done. As in the previous comparison, the group and faculty interaction effect tested whether the difference in results between SciMathUS and their peers were the same in all the faculties. The findings will be discussed in Chapter Four.

3.5.1 Order of analyses

Below is the order in which the different analyses were done:

1. determine relationship between pre and post SciMathUS in Mathematics;
2. determine relationship between pre and post SciMathUS in Physical Sciences;
3. determine relationship between pre and post SciMathUS in Access Test Mathematics subtest;
4. determine relationship between pre and post SciMathUS in Access Test Physical Sciences subtest;
5. determine the relationship between Physical Sciences results and Access Test results in Physical Sciences subtest;
6. determine relationship between post SciMathUS results in Mathematics and first year in HE average;
7. determine relationship between post SciMathUS results in Physical Sciences and first in HE year average;
8. determine relationship between average of former SciMathUS students and main stream students who attended the same schools; and
9. determine relationship between average of former SciMathUS students and main stream students at the end of year one per faculty.

The analyses and findings of these analyses are reported in Chapter Four.

3.6 Reliability and validity

Reliability and validity are central issues in all measurement because all researchers want their measures to be valued as reliable, valid, truthful and credible. If findings are reliable, it suggests that the same scores will be obtained with the same test or with different sets of equivalent items on a different occasion under identical or very similar conditions (Anastasi & Urbina, 1997; Neuman, 2000).

In a quantitative study a reliable measurement means that the same numerical results will be produced by a specific indicator if measured again or to get an accurate estimate of the particular attribute (Mertens, 2005). It does not or will not vary because of characteristics of the measurement process or instrument used. Measures of test reliability make it possible to

estimate what proportion of the total variance of test scores is due to error variance (Anastasi & Urbina, 1997; Mertens, 2005). And yet, Neuman (2000) argues that it is rare to have perfect reliability. He suggests four ways to increase the reliability of measures:

- Clearly conceptualise or identify constructs or variables (success vs achievement);
- Measure at the most precise level as possible;
- use more indicators of the same construct than one; and
- use pre-tests, pilot tests and replicate, as long as the same definition is used (p. 166).

Validity suggests truthfulness and refers to how well an idea about reality fits with actual reality. When a researcher claims that a measurement is valid, he or she suggests that it is valid for a particular purpose. It is rare that a measurement is valid for more than one purpose. It is more difficult to achieve validity than reliability (Neuman, 2000).

According to Neuman (2000) there are four types of measurement validity:

- Face validity, meaning that the indicator measures the construct it claims to measure;
- Content validity, indication that the full content of the definition is represented in the measure;
- Criterion validity, with two subtypes concurrent and predictive validity. Concurrent validity means that the indicator should be associated with a pre-existing indicator that is judged to be valid whereas predictive validity means that an indicator predicts future events that are logically related to a construct.
- Construct validity with two subtypes convergent and discriminant validity. Convergent validity applies when multiple measures of the same construct operate in similar ways whereas discriminant validity means the opposite of convergent validity. When indicators of one construct aims to measure that which are totally different from the construct it wants to measure, it should measure exactly the opposite.

Predictive measurement validity should not be confused with the prediction in hypothesis testing (Anastasi & Urbina, 1997), as can easily be done in this study since the research question was to investigate whether Grade 12 results and university access test results were valid measures to predict success in HE for students who first attended a bridging programme. The test results used in this study, however, are valid measures to determine the performance of students. The findings of this study are reliable because the same results will be revealed if the same analyses are repeated with the same scores of the same students.

3.7 Ethical considerations

All research should be conducted within clearly defined ethical principles to ensure the protection of the participants and the researchers. Resnik (1998) mentions that some people think that scientists need not be instructed about ethics because, by the time one starts doing research, there is little that a person can learn about ethics and morality. That is learnt when one is very young. Students, however, have to learn how to be ethical scientists, because research can also become a career where a person can be tempted to "fudge, fabricate or trim data" (p. 4) in order to get good results and even promotion. It is, however, also necessary to distinguish between ethics and other social norms such as laws. Lying, for instance, is perceived as unethical, but it is not illegal.

Glass (1965) proposes four commandments or principles as the ethical basis of research. The first one is to be completely truthful. The second is to never steal anyone's ideas. The third is to fearlessly defend scientific freedom and inquiry because science cannot prosper where daring thinking is inhibited while the fourth one is to fully communicate one's findings through primary publication, synthesis and instruction.

Resnik (1998) claims the following 12 principles of ethics in science, applied to different aspects of the research process. He says that scientists should

1. be honest and not falsify, fabricate or misrepresent data or results;
2. avoid errors, especially when presenting results;
3. share data, results, methods, ideas techniques and tools as well as allow other researchers to review their work;
4. be free to conduct research on any problem;
5. credit resources where credit is due;
6. educate prospective scientists and the public to ensure that they know how to conduct and honour good research;
7. have a social responsibility about research in the sense that the public is informed about the consequences of research;
8. obey the laws regarding their research;
9. be given the opportunity to use scientific resources to advance in their profession as researchers;
10. treat other research colleagues with respect;
11. use resources efficiently; and
12. treat humans, non-human or animal subjects with respect and care when using them in their research.

A further issue of importance is the relationship between procedural correctness and practical concerns for beneficence, respect and justice, are laid out in the Belmont Report. These three criteria were established by *the Belmont Report: Ethical Principles and Guidelines for the Protection of Human Subjects of Research* produced by a USA Congressional Commission in 1979. Since then these criteria have become a widely used international framework for research ethics (Altink, 1987). The American Sociological Association's (ASA's) Code of Ethics, for instance, sets forth the following principles and ethical standards: professional competence, integrity, professional and scientific responsibility, respect for people's rights, dignity, and diversity and social responsibility (American Sociological Association, 2012).

In this investigation I attempted to maintain objectivity and integrity and to employ professional judgement. The aspiration was to approach the study in an accurate and just way and to report findings as comprehensively as possible. All stakeholders were kept fully informed of the progress and results of the study. All data were treated with the utmost confidentiality. Details of other researchers' work, theories, methods and research design were presented as accurately as possible. Since accountability towards society should also be considered (Babbie & Mouton, 2011; Resnik, 1998), this research was conducted with the intention to make a contribution to the debate about widening access for success especially in the South African context.

The Mathematics, Physical Sciences and AT results were gathered by the researcher from the archives of SciMathUS where I am a full time employee at the time of the research, responsible for marketing and fundraising, also for SciMathUS. Written and signed permission to use this data was obtained from the Director of the Institute for Mathematics and Science Teaching at Stellenbosch University (IMSTUS), where the SciMathUS bridging programme is housed. As a registered Master degree student, written and signed permission to use the first year results of students as well as the Access Test results as recorded on the university management information system, was obtained by the Division for Institutional Research and Planning on 26 April 2012 as well as the Research Ethics Committee: Human Research (Humanities) of Stellenbosch University via Committee Review procedures. The clearance number of this application is HS794/2012. Copies of these permission documents are attached as Addenda 1-3.

3.8 Summary

This chapter presented the research methodology that informed this study; the investigation of Grade 12 results and university access test results as possible predictors of success in HE for students who first attended a bridging programme.

In this chapter the research paradigm, research question, research design and research methodology associated with a quantitative study were discussed. How research paradigms

change and how qualitative and quantitative approaches to research should not be seen as opposites but as ends on a continuum, were also mentioned. The subsequent sections described the participants and how they were selected. After indicating the variables that were chosen to measure the success of the students in higher education, a description of how the data were analysed, the instruments and procedures used for these analyses, as well as the ethical considerations applied in this study, followed. The next chapter discusses the statistical correlations between the variables used in this study. The conclusions, recommendations and limitations of this investigation are discussed in Chapter Five.

4 CHAPTER FOUR

4.1 Introduction

The research question of this study was to determine whether Grade 12 results (Mathematics and Physical Sciences) and university access test (AT) results could predict success in HE for students who first attended a bridging programme. For the empirical investigation part of this study, different statistical analyses were performed in an approach to answer this question. The results of these analyses are reported in this chapter.

The aim of the SciMathUS bridging programme is to allow educationally disadvantaged students whose Grade 12 results are below the standard entrance scores for admittance to HE an opportunity to improve their results in specific subjects and then reapply for HE. In this study the Mathematics and Physical Sciences results[12] were analysed. The first step of this investigation therefore was to determine whether the students' Grade 12 results in these two subjects improved to a level where they could meet the entry requirements to re-apply and accepted into HE. The pre and post intervention results in Mathematics and Physical Sciences of the students who attended SciMathUS were therefore analysed. Only then could it be determined how many of these students indeed enrolled in HE.

The students also wrote two sets of AT, one set at the beginning of the year and one set towards the end of the bridging year. Analyses were done to determine whether there was a difference between the results from the beginning of the year towards the end of the year. The AT was used to obtain a second 'measurement', because it is disputed by researchers such as Altink (1987), Griesel (1999), Zaaiman, Van Der Flier and Thijs (2000), Naumann, Bandalos and Gutkin (2003), Le Roux, Bothma and Botha (2004), Mabila, Malatje, Addo-Bediako, Kazini and Mathabatha (2006), Koch (2007) and Rollnick (2010), whether Grade 12 results are the best predictor of success in HE, especially for low-scoring students. It is also disputed whether one measurement is valid in predicting success.

Zaaiman, Van Der Flier and Thijs (2000) argue that a better predictive validity could be obtained if there was a closer match between the desired performance of the students and the testing process. Since the AT were perceived as being a 'closer match' to HE content as the NSC examination, the AT was chosen as an alternative measurement tool. This was motivated in more detail in section 2.8. It would be interesting to see whether these results indicated something different than the NSC results in this study.

[12] In this programme, students have a choice between two streams: Science and Mathematics and Accounting and Mathematics. Only the Mathematics and Physical Sciences results were used in this study. See section 2.6 for more detail.

4.2 Contextualising Grade 12 results in South Africa

Although the South African education context was briefly discussed in section 2.2, it is necessary to highlight the school context in South Africa and especially the relationship between (or the lack thereof) resources and performance (Letseka, 2009), particularly when discussing Grade 12 or NSC results and performance. It is also important for the interpretation of the results of this study.

4.2.1 Distribution of performance

The severe inequalities in South Africa are still very evident when educational datasets and averages are analysed (Spaull, 2012; Taylor S., 2010). Instead of having a single normal distribution of performance, Spaull (2012) indicates the bimodal distribution of performance in the South African school system in Figures 4.1, 4.2 and 4.3. The data were taken from three independently conducted surveys, from three different grades and at three different points in time, but all three illustrate the same picture: that South Africa has two schooling systems. A minority of students (about 25%) who come from wealthy backgrounds (irrespective of race) attend high quality primary and secondary schools and perform well. They are the students who enrol in HE and who later gain access to the top end of the labour market where they earn high incomes in high productivity jobs (Spaull, 2012).

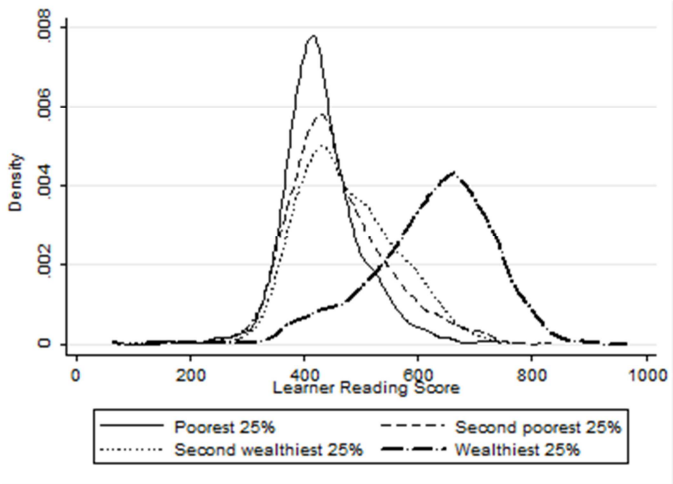


Figure 4.1 Distribution of Grade 6 reading performance by school wealth Quintile (Data: SACMEQ III 2007) Source: (Spaull, 2012)

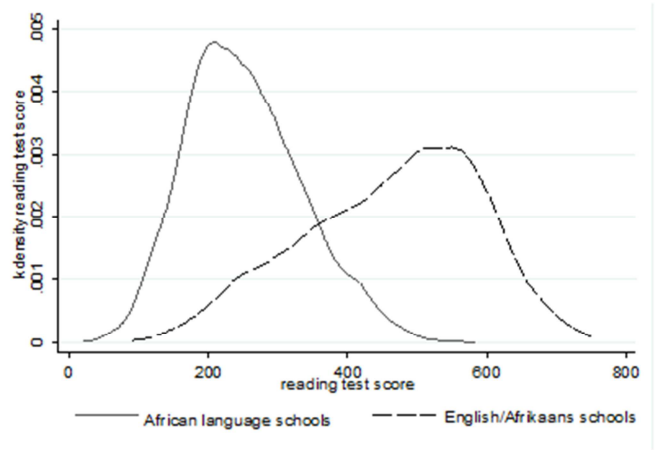


Figure 4.2 Distribution of Grade 5 literacy achievement by language of school (Data: PIRLS 2006) Source: (Spaull, 2012)

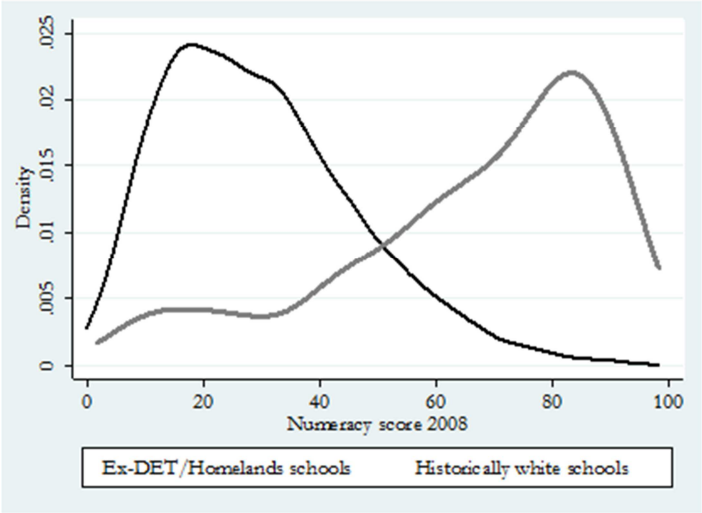


Figure 4.3 Distribution of Grade 4 numeracy achievement by historical education department (Data: NSES 2007/8/9) Source: (Spaull, 2012)

These inequalities are the reasons why it is necessary to identify the schools attended by the SciMathUS students as it will give one a better understanding of the SciMathUS students' performance. It is necessary to know where the schools they attended fit in in this bi-modal distribution.

4.2.2 The quintile system

The National Norms and Standards for School Funding (NNSSF) implemented a policy in 2006 to determine the amount of funding received by the Department of Basic Education for individual schools according to their poverty score. This poverty score assigns a school to a quintile rank (Q1 to Q5) and refers to a school's socio-economic status (SES) (Chutgar & Kanjee, 2009; Department of Basic Education, 2012). Identifying which quintile a school falls into is therefore a crucial step in determining school resource allocation. On the scale of Q1 – Q5, a school in Q1 is perceived as a school with little resources or a poor school whereas a Q5-

school is a school with good resources – a rich school. In 2006, the allocation per learner in Q1 schools was R703 and R117 per learner in Q5 schools. The poverty score of a school, or quintile rank, is based on the poverty level of the community in which it is situated. These scores were calculated using 2006 national census data: weighted household data on income dependency ratio (or unemployment rate), the geographic area within which schools are located and the level of education (or literacy rate) of the community (Chutgar & Kanjee, 2009).

The school's characteristics in Q1-Q4 are not that different, but under the current funding scheme, schools in Q3 receive R194 less per learner than those in Q1. Chutgar and Kanjee (2009) also argue that, in more than one instance, on average, a school in Q1 is better off on some indicators than a school in Q2. According to their study, Q2 schools, which are supposed to be better off than those in Q1, have a greater proportion of disadvantaged learners and have fewer affluent learners than their Q1 counterparts. It is against this background that the SciMathUS results have to be interpreted and why the performance of the schools attended by the SciMathUS students has to be compared to the performance of schools in general. As an example[13], the schools in the Western Cape Province in South Africa were used for this comparison and are indicated in Figure 4.4.

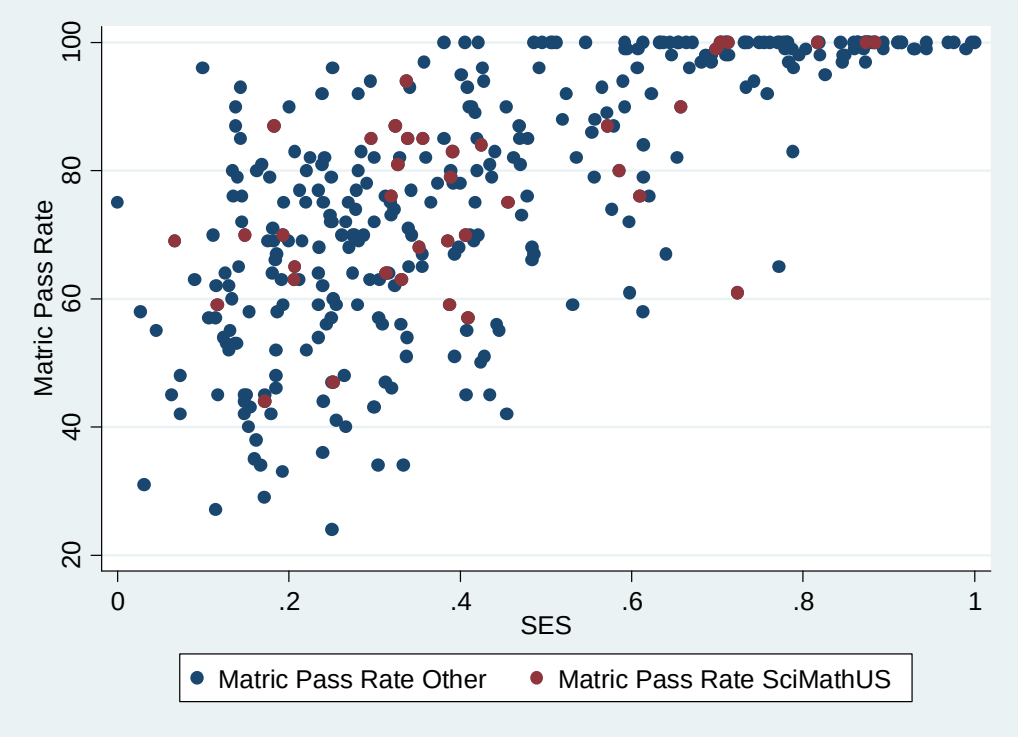


Figure 4.4 Distribution of a sample of Grade 12 results per school per quintile in the Western Cape in South Africa in one specific year (Data: Department of Basic Education)[14]

[13] 2010 was used but chosen for no specific reason.

[14] Graph collated for a presentation at the CTL conference in May 2012 (Müller & Van Wyk, 2012).

In Figure 4.4, the five quintiles in which schools are divided are indicated on the X axis with values between 0 and 1. The value between 0 and .2 indicates Q1 whereas the value between .8 and 1 indicates Q5. The average performance (matric pass rate) of the schools between 20 and 100 percent is indicated on the Y-axis. In this bivariate plot the positive relationship between the variables resources (SES or socio-economic status) and performance is indicated. The general trend is, the higher the SES (on the X axis), the higher the performance, indicated on the Y axis. This is a confirmation of what is reported by researchers like Taylor (2010) and Spaull (2012) – that there is a relationship between resources and performance. (Department of Basic Education, EMIS data, 2012). Since the list on the web site is incomplete, a number of schools were omitted because the quintiles are not indicated. The red dots indicate the schools attended by SciMathUS students.

As mentioned above, the perception is that the lower the quintile of the school the lower that school performs. According to Spaull (2012), only 1% of learners in Grade 8 attending the poorest 80% of schools, will pass matric with Mathematics and Physical Sciences results high enough to qualify for most Mathematical and Science related degree programs at university. He also reports that almost ten times as many students in the wealthiest 20% of schools perform on the level to qualify for HE. It is, however, evident from Figure 4.4 that this is not true for all the schools in all circumstances as some of the low quintile schools did perform well. There are always exceptions to the rule. It must, however, also be taken into consideration that the schools represented here is a very small sample and one cannot generalise on ground of this representation. The study by Chutgar and Kanjee (2009) also indicates that there are questions about the categorisation of schools in quintiles and therefore one should be careful about assumptions about performance versus school quintiles at this stage. They suggest a review of the quintile system.

4.3 Presentation and discussion of results

In this chapter, the results of the different analyses will be presented and discussed. The analyses were performed in four stages. For the comparison of the pre and post-intervention analyses, a mixed model repeated measures ANOVA was conducted with time (pre and post), year as fixed effects and the students as random effect. The time-year interaction effect was tested as part of this analysis which tested whether the change in results from prior to the intervention to after the intervention were the same for all the years (2008-2011). The statistics of the data that were analysed are summarised in Table 4.1 below.

Table 4.1 Statistics on data analysed in this study

Cohort	Group of analysis	n: pre intervention	n: post intervention
2008-2011	Gr 12 Maths	309	330[15]
2008-2011	Gr 12 Physical Science	257	249
2009-2011	AT Maths	241	230
2009-2011	AT Physical Science	186	158
2009-2011	SciMathUS students who enrolled at SU for their first year of study in HE		179
2009-2011	Students who enrolled at SU who attended the same high schools as SciMathUS students		1724
2009-2011	All students who enrolled at SU as first year students		15 039

In Table 4.2, the reason why each analysis was performed, are tabularised and explained.

Table 4.2 Summary of analyses

Goal of analysis	Analysis
Determine whether the programme afforded the students attending a bridging programme the opportunity to qualify for HE	• Analyse the difference in the performance of the NSC in Mathematics and in the NSC Physical Sciences prior and after the intervention • Determine the difference in the Access Test Mathematics and Access Test Physical Sciences prior and after the intervention • Analyse the differences
Determine whether there was a relationship between NSC and AT results, prior to the intervention as well as after the intervention since the combination of these two measurements were used to investigate the validity as predictors of success in HE	Analyse the relationship between NSC and Access test results
Determine whether there was a relationship between the improved Mathematics and Physical Sciences NSC results and/or AT results of the SciMathUS students and their end of the first year in HE results at SU since these two measurements were used to investigate as	• Analyse the end of the first year in HE results of former SciMathUS students • Analyse the results per faculty in four categories[16] • Determine whether there is a correlation

[15] A number of students (13) between 2008 and 2011 took Mathematical Literacy in school and Mathematics in SciMathUS and did therefore not have a pre-intervention Mathematics score.

[16] more than 50%, between 30 and 50%, less than 30% and students who did not write the end of the first year examination

Goal of analysis	Analysis
possible predictors of success in HE	between the NSC results and HE results
Determine whether there was a difference in the performance at the end of year one in HE at SU between former SciMathUS students and students who did not attend SciMathUS but enrolled in the same faculties at SU to have a benchmark for the success of students in HE	• Gather the end of the first year in HE results of students who attended the same schools as the SciMathUS students and who enrolled the same faculties at SU • Categorise the results per faculty • Compared the results of these two groups per the six faculties

4.3.1 SciMathUS results

Between 2001 and 2011, 669 students have successfully completed SciMathUS (Smit, 2011). Since there was a change in the curriculum and as a consequence also a different exit-examination by the Grade 12's in 2008 as discussed in section 2.5.3.2 and section 3.5.2, only the results from 2008-2011 are used in the analyses[17] in this study. During the past four years, all the students who wrote the final examination passed, resulting in the programme having a 100% pass rate. The average improvement in the core subjects was more than15 percentage points per subject each year.

4.3.1.1 Analyses of Grade 12 results prior to and post the SciMathUS intervention

Analysing the results of students' pre-intervention Mathematics results (n=309) and post-intervention results (n=330)[18], 207 of these students (67%) obtained less than 50% for Mathematics and 102 students (33%) obtained more than 50% prior to entering the programme. When their post-intervention results were analysed, 56 of these students (17%) obtained less than 50% for Mathematics and 274 students (83%) obtained more than 50% in Mathematics. The same analyses performed with pre-intervention NSC Physical Sciences results (n=257) and post-intervention NSC Physical Sciences results (n=249)[19], indicated that 210 of these students (82%) obtained less than 50% for Physical Sciences and 47 students (18%) obtained more than 50% prior to entering the programme while 39 of these students (16%) obtained less than 50% for Physical Sciences and 210 students (84%) obtained more than 50% in Physical Sciences after the intervention. This can be considered as a significant improvement as p=0,0000 was revealed in the comparison of each year's pre and post intervention difference. This improvement is illustrated in the following two graphs: Figures

[17] The population used in each analysis differs and will be indicated where appropriate.

[18] A number of students (13) between 2008 and 2011 took Mathematical Literacy in school and Mathematics in SciMathUS and did therefore not have a pre-intervention Mathematics score.

[19] Some students left the programme during the three years under discussion prior to writing the final examination, explaining the difference in the number of students before and after the intervention.

4.5 and 4.6. The blue graph indicates the pre-intervention results in both cases whereas the orange graphs indicate the post-intervention results.

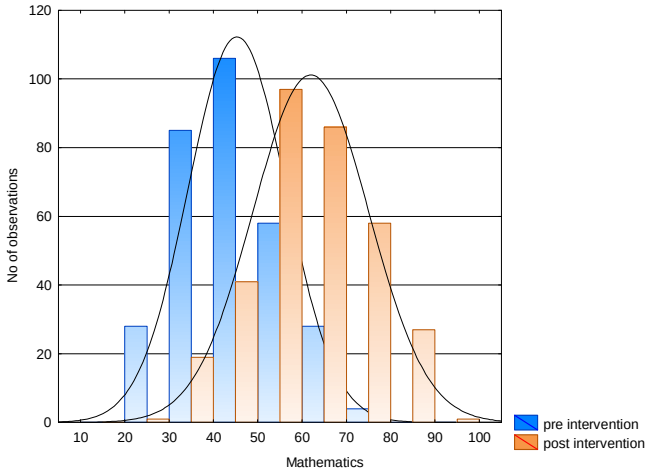


Figure 4.5 Distribution of Mathematics results before and after the SciMathUS intervention

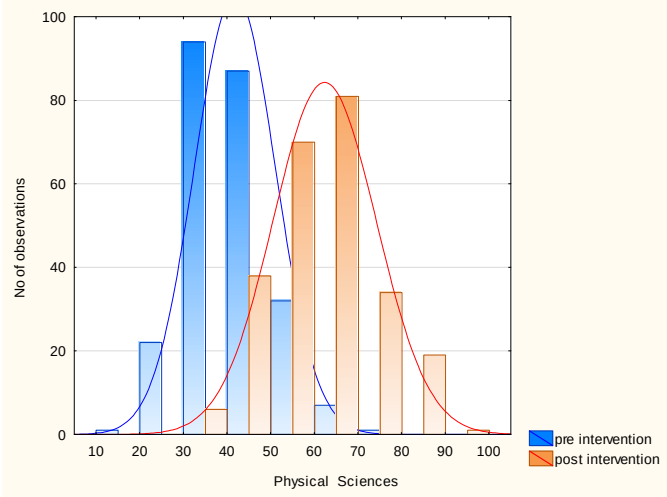


Figure 4.6 Distribution of Physical Sciences results before and after the SciMathUS intervention

Between 82% and 84% of the students obtained more than 50% in Mathematics and Physical Sciences and could therefore apply to be admitted into HE – the prerequisite for admittance in most Mathematical or Science degree programs at Stellenbosch University at that time.

4.3.1.1.1 NSC Mathematics

The difference in the NSC Mathematics results is indicated in Figure 4.7 and Table 4.3 below. A significant increase was observed in the post-intervention results. A significant difference (p=0,0000) is also indicated if the letters on the different ends of one line differ, i.e. e and a on the two ends of the blue line in Figure 4.7. When the averages of these four year groups in NSC Mathematics were compared (n=309), the results on average improved by 19,08

percentage points after attending SciMathUS. The average pre-intervention scores vary between 41 and 46 whereas the post intervention average varies between 58 and 74.

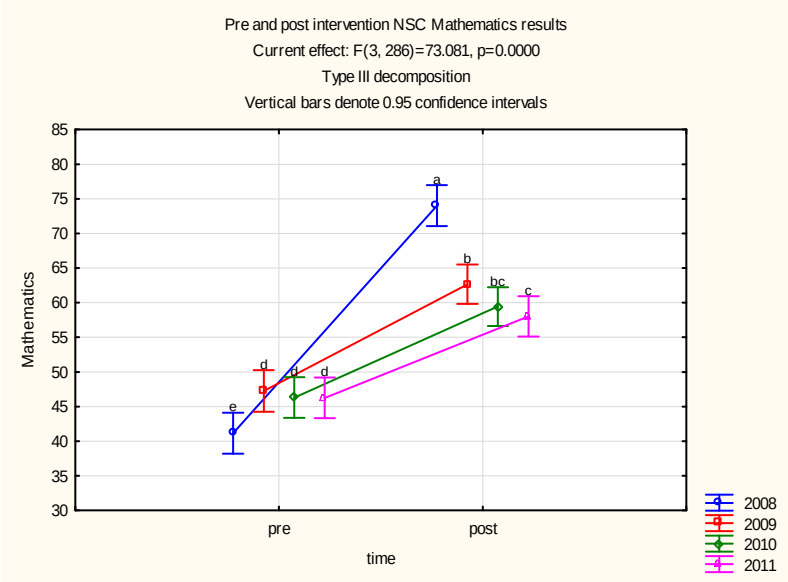


Figure 4.7 Average NSC Mathematics results before and after the SciMathUS intervention [20]

As described in section 2.5.3.2, the former Senior Certificate (SC) was replaced by the new National Senior Certificate (NSC) in 2008. The students who attended SciMathUS in 2008 wrote the 'old curriculum' examination in 2007 as their final exam and the new NSC examination at the end of 2008, the year after attending SciMathUS. It is observed that the 2008 cohort's results were the lowest (41,15%) of the four cohorts prior to entering the programme, but their results were the highest (74,02%) after the intervention. Compared to the differences in the pre and post intervention results of the years following 2008, it may be that the effect of the difference in the results is because different examinations were written. It may then also be an indication of the difference in standards of the different examinations. It may be of interest to investigate this more depth.

Table 4.3 Averages of NSC Mathematics results before and after the SciMathUS intervention

Year of intake	Average % Pre	Average % post	Difference	p
2008	41,15	74,02	32,87	0,0000
2009	47,12	62,65	15,53	0,0000
2010	46,31	59,44	13,13	0,0000
2011	43,24	58,02	14,78	0,0000
Average %	44,46	63,53	19,08	

[20] A significant difference is indicated if the letters on the different ends of one line differ, i.e. e and a on the two ends of the blue line in this graph.

As an example and to illustrate the difference in performance in a specific subject more clearly, the pre and post intervention results in one subject, of one cohort[21] are indicated in Figure 4.8 below. The small open circles, forming the bottom 'line' of the graph, indicate the pre-intervention scores. The post-intervention scores are indicated by the small filled circles. The light blue line indicates the average improvement of this group. The average improvement of this group's results was 13,13 percentage points. (See Table 4.3 above.)

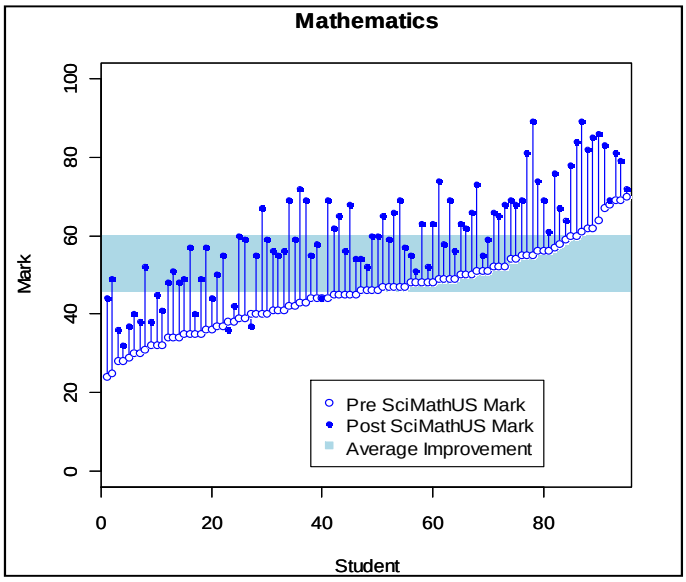


Figure 4.8 Difference in NSC Mathematics results in 2010[22] before and after the SciMathUS intervention

The analysis between the pre and post intervention results in Mathematics revealed a positive correlation (r=0,54) [23], using Pearson correlations. This correlation is also illustrated in Figure 4.9 below. This correlation indicates that, in general, if a student obtained low marks in the NSC Mathematics examination prior to the intervention, he or she will probably obtain low marks after the intervention. The average of the group is higher, as is the case here, but generally, the low (or high) achievers will in all probability be the same people in each case. This, however, does not imply that it is true for all individual students. From Figure 4.8 it is clear that it was not the top achiever prior to the intervention who performed best after the intervention and it was not the student with the lowest marks prior to the intervention who obtained the lowest mark after the intervention.

[21] The 2010 cohort's results in Mathematics are displayed here. This is just an example and was chosen for no specific reason.

[22] This graph was prepared by a colleague from the Department of Statistics and used at the SciMathUS opening function in 2011.

[23] If r is close to 0, it means there is no relationship between the variables. If r is close to one, it reveals a strong positive correlation. If r is close to negative 1, it reveals a strong negative correlation If r is positive, it means that as one variable gets larger, the other gets larger as well (Weisstein, 2012).

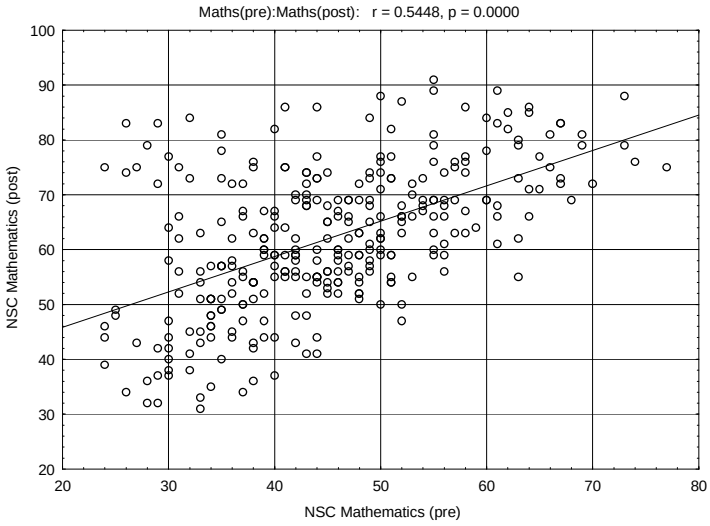


Figure 4.9 Correlation between pre and post SciMathUS intervention scores in NSC Mathematics results

4.3.1.1.2 NSC Physical Sciences

The same analyses were also performed with the NSC Physical Sciences results. The average difference between the pre and post intervention results (n=249) in NSC Physical Sciences over the four years is 21 percentage points (see Table 4.4). As in the case of the NSC Mathematics, the difference between the pre and post-intervention score in NSC Physical Sciences is also the biggest in the 2008 cohort, supporting the inference that the examinations prior to 2008 and after 2008 were on different levels. Each cohort managed to improve their results significantly (p=0,0000) although there was more variation between the improvements in NSC Physical Sciences results than in NSC Mathematics results. A correlation of (r = 0,4485) was yielded between pre and post-intervention score in NSC Physical Sciences. This is also displayed in Figure 4.10[24].

[24] A significant difference is indicated if the letters on the different ends of one line differ, i.e. e and a on the two ends of the blue line in this graph.

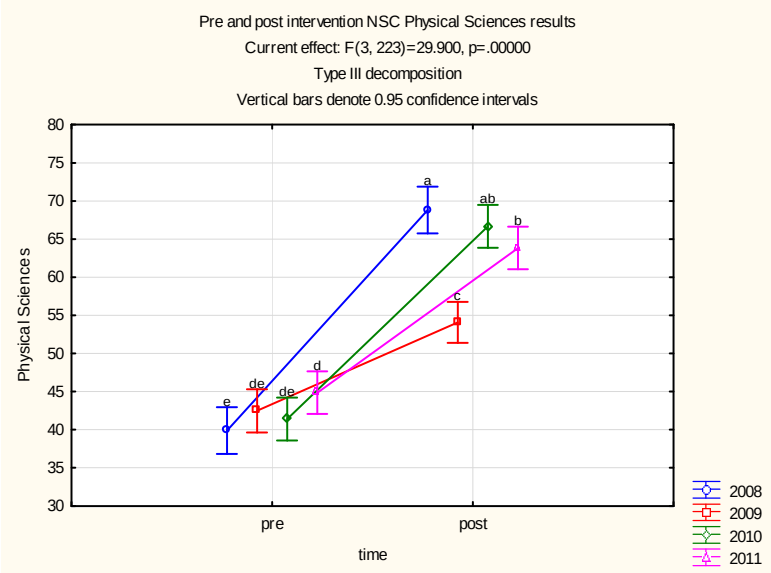


Figure 4.10 Average NSC Physical Sciences results before and after the SciMathUS intervention

Table 4.4 Averages of NSC Physical Sciences results before and after the SciMathUS intervention

Year of intake	Average % Pre	Average % post	Difference	p
2008	39,89	68,8	28,91	0,0000
2009	42,47	54,08	11,61	0,0000
2010	41,40	66,68	25,28	0,0000
2011	44,84	63,84	19,00	0,0000
Average %	42,15	63,35	21,20	

4.3.1.2 Access Test (AT) results

The next step was to analyse the results obtained in the AT in Mathematics and Physical Sciences, prior and post the intervention. In section 2.8.2.1 it was argued why the AT were used. Three cohorts[25] of AT results were analysed. Since the students performed better in the NSC exams after the intervention, it was expected that the students would also perform better in the AT in the post-intervention assessment. It would be interesting to see whether these results indicated something different than the NSC results as the main goal of the AT is to determine whether applicants are adequately prepared for university studies with regard to generic language, numeracy and thinking skills, as well as curriculum-specific skills in Mathematics and Physical Sciences (Negash, Olusola, & Colucci, 2011).

[25] In 2008, only one set of tests were written by the students and therefore only one set of data exists for that year. This data could therefore not be included in the analyses of the AT results.

4.3.1.2.1 AT subtest Mathematics

In Figure 4.11, below, the pre (n=241) and post (n=208) intervention scores of each of the three cohorts in the Mathematics subtest are indicated. The 2009 intake's pre-intervention scores were lower than the others. These are the results of the first group of students who wrote the new curriculum's NSC examination at the end of 2008. What was however observed was that all three the cohorts' post intervention results increased significantly[26] and to more or less the same level (between 37 and 39 – see Table 4.5). The assumption that, because the students performed better in the second NSC examination they would also perform better in the AT Mathematics after the intervention, was correct.

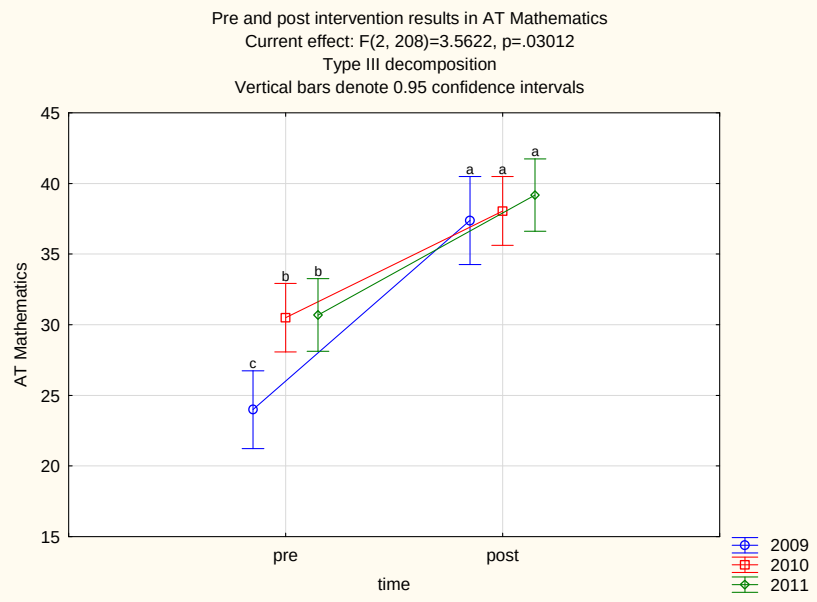


Figure 4.11 Difference in Access Test Mathematics results before and after the SciMathUS intervention

The pre and post intervention AT scores in Mathematics are given in Table 4.5. On average the AT improvement in Mathematics was 9,8 percentage points whereas the NSC improvement in Mathematics on average increased with 19,08 percentage points (see Table 4.3).

Table 4.5 Averages of Access Test Mathematics results before and after the SciMathUS intervention

Year of intake	Average % Pre	Average % post	Difference	p
2009	24,00	37,38	13,38	0,0000
2010	30,50	38,05	7,55	0,0000
2011	30,69	39,18	8,49	0,0000
Average %	28,40	38,20	9,81	

[26] A significant difference is indicated if the letters on the different ends of one line differ, i.e. c and a on the two ends of the blue line in this graph.

4.3.1.2.2 AT subtest Physical Sciences

In Figure 4.12, below, the average improvement of the pre and post intervention scores in the AT Physical Sciences for all three cohorts[27] but for the group as a whole (n=158) is indicated. Since the improvement in the three cohorts' results from the pre to the post intervention results were almost the same in all three years (indicated by an interaction p=0,13), the results were presented as one set of data. Since the students improved their NSC results in Physical Sciences, the assumption was that the students would also perform better in the AT Physical Sciences after the intervention. The assumption was correct: the results of the AT subtest in Physical Sciences increased with 8,4 percentage points. This is, however, lower than the increase in the NSC Physical Sciences results of 21 percentage points (see section 4.4.1.1.1), but the improvement is still significant for each year (p=0,0000).

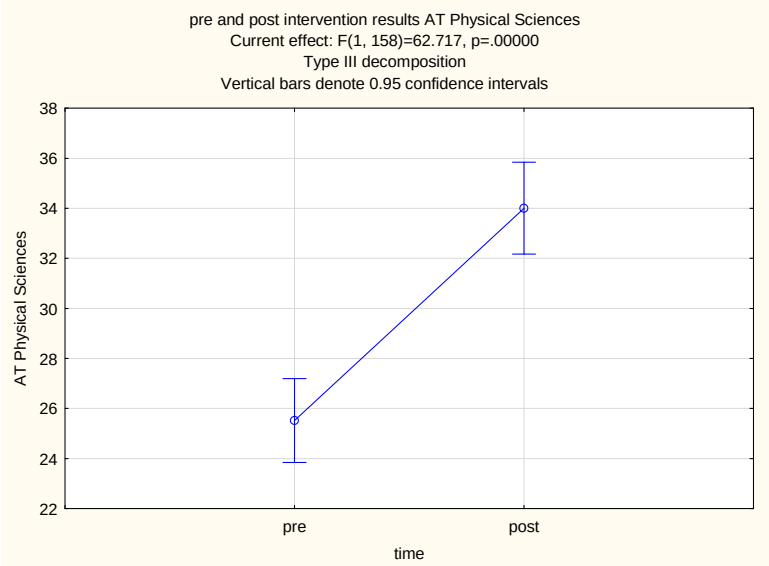


Figure 4.12 Difference in Access Test Physical Sciences results before and after the SciMathUS intervention

Table 4.6 Averages of Access Test Physical Sciences results before and after the SciMathUS intervention

Year of intake	Average % Pre	Average % post	Difference	p
2009	22,63	31,05	8,42	0,0000
2010	27,14	33,70	6,56	0,0000
2011	26,73	37,03	10,30	0,0000
Average %	25,50	33,93	8,43	

According to Bothma, Botha and Le Roux (2004) as well as Nel and Kistner (2009) the main goal of the AT is to determine whether students are adequately prepared for university studies with regard to generic language, numeracy and thinking skills, as well as curriculum-specific

[27] In 2008, only one set of tests were written by the students and therefore only one set of data exists for that year. This data could therefore not be included in the analyses of the AT results.

skills in Mathematics and Physical Sciences. The relatively low increase in the SciMathUS students' AT results, both in Mathematics and in Physical Sciences, raises the question whether these students were prepared for HE. Another question is whether a low performance in the AT compared to the higher improvement in NSC results, possibly an indication of the discrepancy between what is taught in school to the groups of learners in the new curriculum. Are the learners in school indeed prepared for HE? Another possibility is that the students were not as motivated to perform well in the AT as they were in the NSC examination.

4.3.2 Relationship between NSC results and AT results

Since the research question in this study was to determine whether Grade 12 results and university AT could predict success in HE for students who first attended a bridging programme, it was necessary to determine whether there was any relationship between NSC results and AT results, and if so, what it was.

The first analyses were done to determine the relationship between the NSC results and AT results prior to the intervention in each of the two disciplines (Mathematics and Physical Sciences) and then repeated with the two sets of results obtained after the intervention. Relationships between different sets of results were tested, using Pearson correlations.

In the analysis of the relationships between AT and NSC results, the following results were revealed:

- AT Mathematics and NSC Mathematics before the intervention, r = 0,37, p=0,0000;
- AT Physical Sciences and NSC Physical Sciences, before the intervention, r = 0,4, p=0,0000;
- AT Mathematics and NSC Mathematics after the intervention, r = 0,43, p=0,0000; and
- AT Physical Sciences and NSC Physical Sciences after the intervention, r = 0,56, p=0,0000.

On grounds of the analyses, it was clear that there is a positive relationship between the NSC results and the AT results, both before and after the intervention, indicating that, if a student performed well in the NSC, he or she would probably also perform well in the Access tests. The correlations appear to be more significant after the intervention; 0,43 and 0,56 after the intervention in comparison to the 0,37 and 0,4 before the intervention. The correlations between the AT and NSC results in both subjects also appear to be stronger after the intervention. This indicates that the results in the AT would probably better predict a better performance in the NSC results after the intervention. The positive correlations, indicated in

the line with the positive slope from left to right that is drawn through the dots, are also illustrated in the bivariate plots in Figures 4.13 and 4.14.

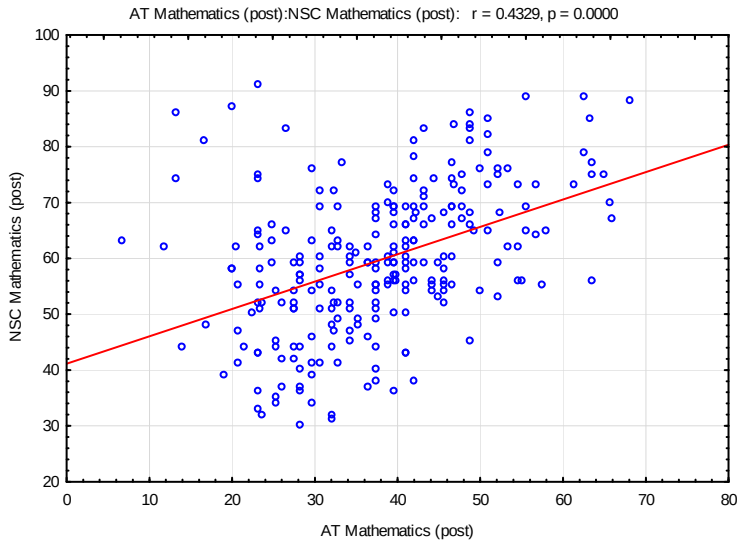


Figure 4.13 Relationship between AT Mathematics and NSC Mathematics after the SciMathUS intervention

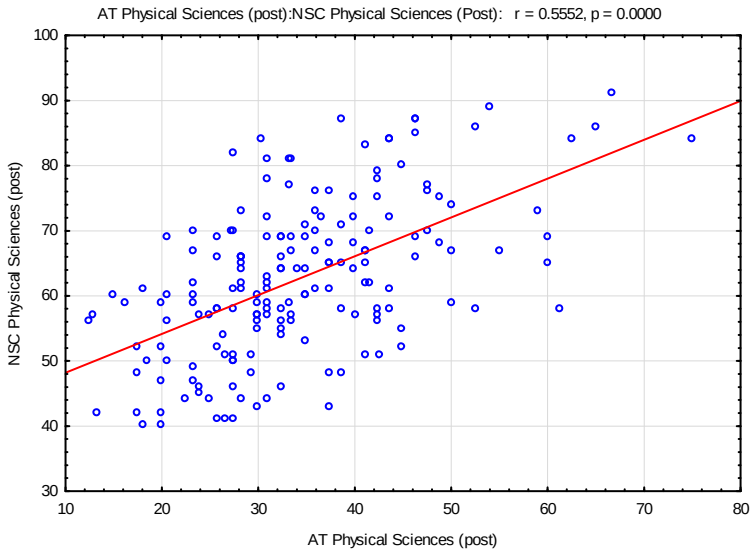


Figure 4.14 Relationship between AT Physical Sciences and NSC Physical Sciences after the SciMathUS intervention

4.3.3 Higher education results: access for success

4.3.3.1 Results of the former SciMathUS students at the end of the first year in HE

The analyses of the pre and post intervention NSC Mathematics and Physical Sciences results revealed that the majority of the students' post-bridging programme results improved significantly (p=0,0000) to a level where they could enrol and participate in HE. This was discussed in section 4.4.1.1.1 These students' AT results also improved significantly

(p=0,0000) as indicated in section 4.4.1.2.1. In terms of the access for participation argument discussed in section 2.4.1, this programme succeeded in affording the students access to participate in HE. As indicated in section 4.4.1.1, more than 80% of the students in this investigation obtained improved results to a level where they could enrol in HE at that stage[28]. SciMathUS therefore had a high access for participation rate. It was however necessary to determine the access for success rate. Participation in HE is not being successful in HE. The following step was to determine how many of the SciMathUS students enrolled in HE and if they did, how they performed. Only students who enrolled at Stellenbosch University were included in this investigation. As indicated in section 3.5.2, the HE data was drawn from the Stellenbosch University student record and collated in one data set, together with the students' NSC and AT results.

For this study, success was defined as success at the end of the first year in HE. The reason why this point was chosen as well as the recognition of the limitation for choosing this point as the measurement of success was discussed in section 2.9.2. Apart from the fact that the majority of students were still enrolled in HE, many students internationally fall out of HE at the end of year one. To have a 'benchmark' of the SciMathUS students' performance, though, and to achieve some form of homogeneity, the SciMathUS students' performance in HE was measured against the success of their peers who attended the same schools and who enrolled in the same faculties in HE at Stellenbosch University directly after school without attending SciMathUS.

Of the sample of students who attended SciMathUS and whose pre and post intervention results were analysed (n=239), only 179 students enrolled at Stellenbosch University after completing SciMathUS between 2009 and 2011. This group's performance in HE was analysed.

In Table 4.7, the former SciMathUS students' enrolment in six faculties at Stellenbosch University is indicated. The biggest number of the former SciMathUS students enrolled in the Faculty of Science (39%), followed by 25% of the students who enrolled in the Faculty of Economic and Management Sciences and 12% in the Faculty of Engineering. Less than 10% of the students enrolled in each of the Faculties of AgriSciences, Social Sciences and Medicine and Health Sciences. The average percentage achieved at the end of their first year was used as the indicator of success in HE performance. This score was chosen as it is an indication of the students' real performance, irrespective of the number of modules taken during the year. Of the 179 students from this group who enrolled at SU, 77 students (43%) obtained more than 50% on average at the end of their first year of study. Fifty percent is considered as a pass. A further 64 students (36%) obtained more than 30% at the end of their

[28] The entry requirements for HE and for specific degree programmes change and have definitely changed at SU since 2008.

first year. Thirty five students did not obtain more than 30% (failed). Of these 35 students, 3 students (2%) did not write the examinations at the end of the year.

The results were categorised as follows: more than 50%, between 30 and 50%, less than 30% and students who did not write the end of the first year examination. These categories were chosen because, at Stellenbosch University, in order to pass a module, a student has to obtain a final mark of not less than 50% (Stellenbosch University, 2011, p. 226). With exceptions, and taking into consideration the sliding scale applicable to students taking approved extended programmes, a student will be refused further admission as a student unless he or she has obtained at least 0,33 HEMIS (Higher Education Information Management System) credits at the end of year one of study (Stellenbosch University, 2011, p. 202). A student, who wishes to graduate, has to pass all the required credits before a qualification can be obtained.

Table 4.7 Former SciMathUS student enrolment per faculty and performance at the end of year 1 at Stellenbosch University: 2009-2011

Enrolment in all programmes in the different Faculties	Total	Number of students who passed year 1 (average ≥ 50%)	% of this group	Number of students with an average 30% - 50% and could continue to year 2	% of this group	Number of students who did not pass year 1 (average < 30%)	% of this group	Did not write the end of year 1 exam	% of this group
AgriSciences	16	7	44%	4	25%	4	25%	1	6%
Economic and Management Sciences	45	15	33%	19	42%	11	24%		
Engineering	22	7	32%	5	23%	10	45%		
Medicine and other Health Sciences	12	11	92%	1	8%	0	0%		
Sciences	69	27	39%	31	45%	10	14%	1	1%
Social Sciences	15	10	67%	4	27%	0	0%	1	7%
Total	**179**	**77**	**43%**	**64**	**36%**	**35**	**20%**	**3**	**2%**

Compared to the data released by the Department of Education (2005) (latest official figures available) and as discussed in section 2.5.3.3 where it is reported that 30% dropped out in their first year of study[29], (Letseka, 2009), the figures of the SciMathUS students compare favourably to the above-mentioned national figures; 79% of the former SciMathUS students' results in the three cohorts studied and who enrolled at Stellenbosch University, either passed their first year (43% of the group) or performed well enough to be allowed to continue with their studies to their second academic year (another 36% of the group). In terms of the access for success rate as discussed in section 2.4.1, this programme has an access for success rate of either 43% (students who obtained an average of 50% and more at the end of their first year in HE) or 79% (students who obtained an average of 30% and more at the end of their first year in HE and were officially allowed to continue to year 2 at SU).

[29] 20% more students in this cohort studied, dropped out during their second and third years. Only 22% graduated within the minimum three years duration to finish a generic Bachelor's degree (Letseka, 2009).

4.3.3.2 Correlation between Grade 12 results and results at the end of year one in HE

In a further attempt to address the research question - whether Grade 12 results and university access test results could predict success in HE for students who first attended a bridging programme - the next sets of data analyses were performed to determine the correlation between the post intervention (Grade 12) results in Mathematics and Physical Sciences and the performance at the end of the first year in HE.

In the comparisons of SciMathUS students with their peers from the same schools and enrolled in the same faculties, a two-way ANOVA with group and faculty as the two factors were done. The group and faculty interaction effect tested whether the difference in results between SciMathUS and their peers were the same in all the faculties.

Although more than 80% of the former SciMathUS students passed Mathematics and Physical Sciences on a level to qualify for HE at the end of the bridging year (see section 4.4.1.1.1), and although 79% of them could academically continue to their second year (43% with an average of more than 50% and 36% with an average of between 30% and 50% and therefore allowed to continue to year 2 (see section 4.4.3), no correlations could be found between the students' post intervention AT results and their performance in HE. Relationships between different sets of results were tested, using Pearson correlations, yielded the following:

- NSC Mathematics post intervention and the average obtained at the end of year one in HE, r = -0,0160, p = 0,8330;
- NSC Physical Sciences post intervention and the average obtained at the end of year one in HE r = 0,1126, p = 0,1985;
- AT Mathematics post intervention and the average obtained at the end of year one in HE, r = -0,0733, p = 0,4443; and
- AT Physical Sciences post intervention and the average obtained at the end of year one in HE, r = -0,0350, p = 0,7638.

The assumption was, that, once the bridging programme students' results improved to a level good enough to participate in HE, there would be a positive correlation between their improved NSC results and HE results. The results obtained in this study are in accordance with the debate by researchers such as Griesel (1999), Zaaiman, Van Der Flier and Thijs (2000), Naumann, Bandalos and Gutkin (2003), Mabila, Malatje, Addo-Bediako, Kazini and Mathabatha (2006), Koch (2007), Rollnick (2010), Potgieter, Davidowitz and Venter (2010), Schöer, Ntuli, Rankin, Sebastiao and Hunt, 2010, Du Plessis and Gerber (2012) and others over a spectrum of time (discussed in section 2.8.1), about the reliability of final school results as predictors of success in HE. According to Potgieter, Davidowitz and Venter (2010)

"prediction of success is typically more accurate for better performing students" (p.12). The issue to be investigated and verified is what better performing or high- and low-scoring means in the current curriculum.

4.3.3.3 Comparison of results between former SciMathUS students and their peers at the end of year one in HE

Since no correlation could be found between the improved Grade 12 results and results obtained at the end of year one in HE for the former SciMathUS students, it was decided to compare the results of the former SciMathUS students at the end of their first year with the results of their peers from the same schools who enrolled in the same faculties at Stellenbosch University but who entered HE directly after school without attending the SciMathUS first. The performances of the two groups were compared per faculty because the sample was too small to do comparisons per degree programme. It was explained in section 3.4.3 why these students were chosen. In terms of homogeneity, this group of students was the closest to the group of students in SciMathUS to compare their success rates by.

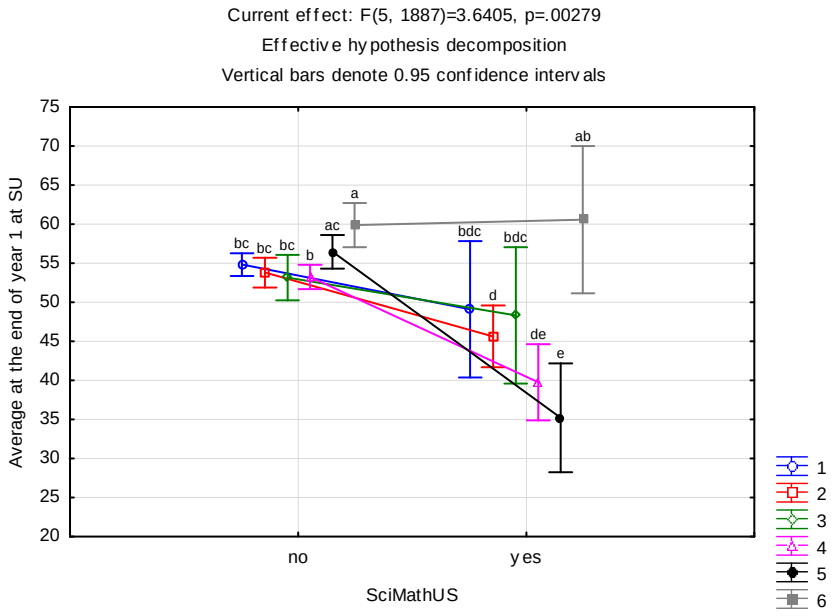
Table 4.8 Enrolment per faculty at the end of year 1 at Stellenbosch University: former SciMathUS students vs their peers from the same schools who entered HE directly after school

Faculty[30]	SciMathUS students who enrolled at SU for their first year of study in HE	Students who enrolled at SU who attended the same high schools as SciMathUS students
Social Sciences (1)	15	501
Sciences (2)	69	294
AgriSciences (3)	16	127
Economic and Management Sciences (4)	45	441
Engineering (5)	22	229
Medicine and other Health Sciences (6)	12	132
TOTAL	**179**	**1724**

The former SciMathUS students enrolled in six different faculties at Stellenbosch University as indicated in Table 4.8. As discussed in section 3.5.2, 1724 students from the same schools as the SciMathUS students enrolled at SU between 2009 and 2011. The number of students representing these 61 schools is 13% of the total number of first year students (15 039) for these three years. The number of students who attended SciMathUS represents 11% of these 1724 students and 1% of the total population of first years at Stellenbosch University in 2009-2011. The SciMathUS students' results were only compared to the results of their peer group from the same schools and not to the whole group of first years.

[30] The number next to each faculty corresponds with the coloured line in Figure 4.15

In three of the faculties, Medicine and Health Sciences, AgriSciences and Social Sciences there was no significant difference[31] between the performance of the former SciMathUS students and their peers who achieved more than 50% on average at the end of their first year. This indicate that these students performed on par with their peers from the same schools who did not attend the bridging programme prior to entering HE. In the Faculties of Engineering, Economic and Management Sciences and Sciences the former SciMathUS students were, however, outperformed by their peers from the same schools. This is illustrated in Figure 4.15 below.



1 = Social Sciences	2 = Natural Sciences	3 = AgriSciences	4 = Economic and Management Sciences	5 = Engineering	6 = Medicine and other Health Sciences

Figure 4.15 Performance of SciMathUS students compared to their peers who attended the same schools but directly enrolled in HE, illustrated per faculty enrolment at SU.

4.4 Conclusion

The research question of this study was to determine whether Grade 12 results and university access test results could predict success in HE for students who attend a bridging programme prior to entering HE. The possible relationships and correlations of various variables were examined and reported on in this chapter.

The findings of this research are summarised in the table below:

[31] A significant difference is indicated if the letters on the different ends of one line differ, i.e. ac and e on the two ends of the black line in this graph.

Table 4.9 Summary of analyses and findings

Goal of analysis	Analysis	Finding
Determine whether the programme afforded the students attending a bridging programme the opportunity to qualify for HE	• Analyse the difference in the performance of the NSC in Mathematics and in the NSC Physical Sciences prior and after the intervention • Determine the difference in the Access Test Mathematics and Access Test Physical Sciences prior and after the intervention • Analyse the differences and relationships	• On average, students significantly improved (p=0,0000) their NSC results; with 19,08 percentage points in Mathematics and 21 percentage points in Physical Sciences after attending the SciMathUS programme over four years (2008-2011). • On average, students significantly improved (p=0,0000) their AT results; with 9,8 percentage points in AT Mathematics and 8,4 percentage points in AT Physical Sciences in the three years investigated (2009-2011). • A positive correlation (r=0,54) was yielded between pre and post intervention results in NSC Mathematics. • A positive correlation (r=0,44) was yielded between pre and post intervention results in NSC Physical Sciences.
Determine whether there was a relationship between NSC and AT results, prior to the intervention as well as after the intervention	Analyse the relationship between NSC and Access test results	A positive correlation (r = 0,43; p=0,0000) was yielded between AT Mathematics and NSC Mathematics after the intervention, as well as

Goal of analysis	Analysis	Finding
since the combination of these two measurements were used to investigate the validity as predictors of success in HE		and between AT Physical Sciences and NSC Physical Sciences (r = 0,56; p=0,0000) after the intervention, indicating that, if a student performs well in the NSC, they will probably also perform well in the AT.
Determine whether there was a relationship between the improved Mathematics and Physical Sciences NSC results and/or AT results of the SciMathUS students and their end of the first year in HE results at SU since these two measurements were used to investigate as possible predictors of success in HE	• analyse the end of the first year in HE results of former SciMathUS students • Analyse the results per faculty in four categories • Determine whether there is a correlation between the NSC results and HE results	No correlation could be found between the improved Mathematics and Physical Sciences NSC results and/or AT results of the SciMathUS students and their end of the first year in HE. (All correlations indicated in section 4.4.3.2.)
Determine whether there was a difference in the performance at the end of year one in HE at SU between former SciMathUS students and students who did not attend SciMathUS but enrolled in the same faculties at SU to have a benchmark for the success of students in HE	• gather the end of the first year in HE results of students who attended the same schools as the SciMathUS students and who enrolled the same faculties at SU • categorise the results per faculty • Compared the results of these two groups per the six faculties	The former SciMathUS students performed on par with their peers in the Faculties of Medicine and Health Sciences, AgriSciences and Social Sciences but were outperformed by their peers from the same schools in the Faculties of Engineering, Economic and Management Sciences and Sciences.

The fact that the majority of these students, however, passed or performed well enough to continue to their second year, alerts one to the argument that success is a complex issue and that looking at it from only one (quantitative) perspective does not do justice to the issue. In spite of the fact that their success could not be predicted, a number of students passed their first year. As discussed in section 2.9.3.1, there are numerous individual attributes that should

to be taken into consideration when student success is discussed. Some of these issues are the student's growth mind-set (Dweck, 2010), the student's attitude and self-belief (Schunk & Pajares, 2005), the student's academic preparedness (Evans, 2000) and the circumstances at the institution where the students enrol, as argued by Astin (1993), Tinto (1987 and 1994), Pascarella and Terenzini (1991 and 2005) and Kuh, Kinzie, Schuh and Whitt (2005). These issues were not investigated for this group of students. More research is needed to discover what led to the success of the students investigated in this study. It is equally important to know what led to the success of some as it is to know what led to a number of students not succeeding.

In reflecting on this research in the next chapter, the recommendations for future research as well as the strengths and limitations of this investigation will also be discussed.

5 CHAPTER FIVE

5.1 Introduction

The purpose of this chapter is to integrate the results obtained during the empirical investigation and reported on in Chapter Four with the theoretical aspects emanating from the literature as discussed in Chapter Two. The philosophy that informed the study was discussed in Chapter Three. A review of the strengths and limitations of the study is followed by suggestions for future research, the researcher's reflections and concluding remarks.

5.2 Discussion of research findings

The research question of this study was to determine whether Grade 12 results (Mathematics and Physical Sciences) and university access test results could predict success in HE for students who attend a bridging programme before entering HE. The variables considered in this study were Grade 12 results and Stellenbosch University Access Tests results.

The literature review in Chapter Two provided the backdrop against which the need for more people to enter HE was sketched. The knowledge economy needs multi-skilled people embarking on a lifelong-learning journey. As this research was about a bridging programme offered in South Africa, it was necessary to discuss the education system and its history in this country. Widening access, however, is an international issue. Therefore the different kinds of access programmes and the research being done on these programmes internationally were also discussed in Chapter Two. It was in this context that the SciMathUS bridging programme, the programme under investigation in this research, was introduced to this study.

The question may rightly be asked why it is necessary to predict the success of students in HE. The greater demand for access in HE, locally and internationally, puts pressure on institutions and national budgets. The students who enrol (who are allowed to participate) are expected to be successful and graduate. Given the limited number of places available and the budgetary constraints, institutions have to select whom they want to allow to participate. They want to know that those who are admitted will be successful. In South Africa, apart from the societal need for more HE-qualified people, the country has to redress the injustice of unequal access to education of the past. In spite of being almost 20 years into a new dispensation, the majority of school leavers are still inadequately prepared for HE. Final school results are expected to indicate who would be successful in HE, but if the quality of schooling is questionable, the use of these results for the purpose of selection, evaluation or prediction of success is also questionable.

Other measurements that are used internationally were studied. As in the other research surveyed, an alternative measurement was also investigated in this study to predict success.

The use of the Stellenbosch University Access Test was explored as the alternative to use alongside Grade 12 results to predict the success of the SciMathUS bridging programme students in HE. The different kinds of tests that are used for selection or admission are tests such as achievement tests, aptitude tests, ability tests, skills tests and access tests. Dynamic assessment and assisted learning, demographic factors and personal interviews are also considered. Using additional admission tests alongside the NSC results for admission into HE could, however, also be perceived as expressing distrust in the school system. It also opens up the possibility that prospective students may be coached for these alternative tests. These are valid points that have to be taken seriously when alternative measurement tools are considered.

A student enters HE with the aim to obtain a degree, to be successful. The volume of research that has been published on success and the factors that might influence a student's success was an indication that success cannot only be measured statistically. There are many dimensions of success or increased success, as argued by researchers such as Pascarella and Terenzini, 2005; Tinto and Pusser, 2006; Astin, 1999; Kuh, Kinzie, Schuh and Whitt, 2005. Apart from particular student characteristics and positive institutional conditions, Morrow's argument, with some others, about epistemological access seems appropriate to tie the theoretical constructs and themes centred on access and success together. The SciMathUS programme follows a hybrid problem-based approach to teaching and learning, allowing and actively assisting the students to learn how to take responsibility for their own learning. This resonates well with Morrow's (2009) argument that epistemological access is learning how to become a successful participant in academic practice.

In this study success was defined from a quantitative perspective and measured by the results (average percentage) obtained by the students at the end of their first year in HE at Stellenbosch University. It is important to remember, however, that there is a link between quantitative and qualitative issues, even in this quantitatively defined study. The context in which any research is conducted, is important. It was necessary to determine how many students passed and failed (do the quantitative analysis) but this cannot be studied in isolation It is necessary to understand the social setting(s) in which they occur.

In the attempt to determine the quantitative factors (passes and fails), statistical analyses were conducted. This was discussed in detail in Chapters Three and Four. Through empirical investigations the possible relations and correlations of Grade 12 and Access Test results as variables were analysed. In the comparisons of SciMathUS students' performance in HE, they were compared with their peers from the same schools and who enrolled in the same faculties.

Students initially enrolled in SciMathUS because their Grade 12 results were not good enough to be admitted in HE. They rewrote NSC Mathematics and Physical Sciences as well as the two sets of AT during the year. The analyses of the pre- and post-intervention results of these

two subjects as well as the two sets of AT results revealed a significant improvement and the majority of students in the years investigated improved to a level good enough to proceed to HE. The majority of them enrolled at Stellenbosch University the year after completing the programme successfully. The programme therefore makes a contribution towards allowing students access for participation as discussed in section 2.4.1.

A positive correlation was further yielded between the improved NSC results and improved AT results obtained by the students in Mathematics and Physical Sciences. This led to the assumption that these improved Grade 12 results would correlate with the results obtained by them in HE. The assumption in the literature by some researchers (Botha, McCrindle, & Owen, 2003; Du Plessis & Gerber, 2012; Schöer, Ntuli, Rankin, Sebastiao, & Hunt, 2010) that there is a correlation between high Grade 12 scores and performance in HE led to the hypothesis in this study that the improved Grade 12 (Mathematics and Physical Sciences) results of the students in this group would positively correlate with the results obtained by them in HE. The findings of this study could, however, not confirm this assumption. Neither the NSC nor the AT was a good predictor of success in HE for the students who first attended a bridging programme.

Final school results as an example of an achievement test are expected to correlate with success in HE, because "a student needs to have some mastery of knowledge and skills offered in previous education to be able to profit from subsequent education" (Altink, 1987, p. 2). This is true for students with high scores, but it cannot be true for students who did not receive quality education while they were at school. Since many students in South Africa do not receive quality education, the use of Grade 12 results for the purpose of selection, evaluation or prediction of success is questioned by a number of authors (Koch, 2007; Rollnick, 2010; Zaaiman, Van Der Flier, & Thijs, 2000; Nel & Kistner, 2009; Griesel, 1999, updated 2000; Naumann, Bandalos, & Gutkin, 2003). Studies were also conducted by a number of researchers to determine the correlation between Grade 12 results and performance in HE in South Africa (Du Plessis & Gerber, 2012; Botha, McCrindle, & Owen, 2003; Maree, Pretorius, & Eiselen, 2003; Potgieter, Davidowitz, & Venter, 2010). Correlations were revealed between Grade 12 results and performance in HE in other studies, contrary to the findings in this study. Most of the studies were, however, conducted when the previous curriculum was still being used in South Africa. Schöer, Ntuli, Rankin, Sebastiao and Hunt (2010) revealed the difference in the academic (Mathematics) ability of former SC matriculants and the NSC school-leavers in their study when they compared the performance of students in Economics 1 and Computational Mathematics of 2008 and 2009. The findings of these studies highlighted interesting issues that also inform the recommendations for future studies mentioned in section 5.5.

In the analyses of the AT and NSC scores, it was found that the improvement in the AT was considerably lower than the improvement in the NSC scores. This raises a few questions. Although the National Benchmark Tests are used nationally for placement in HE from 2012, the question is whether the small increase in AT, developed before 2008, is perhaps an indication that students are less prepared for HE after 2008. Bothma, Botha and Le Roux (2004) argue that the AT measure preparedness for HE. That would be in line with the finding of Schöer, Ntuli, Rankin, Sebastiao and Hunt (2010), whose study revealed a significant difference between the academic ability in Mathematics of former SC matriculants and NSC matriculants. The change in the curriculum could also be a reason for this, as the students assessed for this study are mostly students who were taught in the new curriculum during their school years, whereas the AT was developed before 2008. The next question relates to the issue raised by Du Plessis and Gerber (2012), who investigated whether the NBT is a better indicator of academic preparedness than NSC. They, however, ask the question whether tests for academic preparedness give sufficient information about the potential to succeed. Their question may also be relevant for this study, as the AT and the NBT are both tests that measure academic preparedness.

It is also possible that the students may have viewed the NSC in a much more serious light than the AT, and therefore put in more effort to perform well in the NSC examination. As is the case in the Du Plessis and Gerber (2012) study, the SciMathUS students had also already been admitted into the programme when the AT was administered for the first time. The second test was administered towards the end of the bridging year, shortly before the students rewrote the NSC examinations. The students might not have viewed this test as important at the time when it was administered.

In spite of the fact that the majority of SciMathUS students passed their NSC examinations after attending the programme with results good enough to proceed to HE (82% and 84% in Mathematics and Physical Sciences respectively) and in spite of the fact that the majority of students passed their first year in HE with results good enough to proceed to their second year (43% of them with an average of more than 50% and another 36% with an average of between 30% and 50%), no correlation could be found between the high(er) Grade 12 scores and performance in HE in this group. This also raised the question of what high and low scoring means. As indicated in section 4.4.3.2, the attribution of a value to high and low scoring may affect the predictive value of Grade 12 and AT results for success in HE. More research to determine the parameters of high and low scoring could clarify this. One way would be to analyse the individual students' performances and not only analyse the group as a whole.

The majority of the students studied in this research passed or performed well enough to continue to their second year in spite of the fact that their success could not be predicted by looking for correlations between their Grade 12 and end of their first year results. This alerts

one to the argument that success is a complex issue. Looking at it from only one (quantitative) perspective does not do justice to the issue of success. As discussed in section 2.9.3.1, there are numerous individual attributes that should to be taken into consideration when student success is discussed. Although these issues were not researched in this study, Dweck (2010) argues that a growth mind-set of a student is important, Schunk and Pajares (2005) highlight the importance of a students' own attitude and self-belief and Evans (2000) emphasises the importance of being academically prepared, having learning strategies and self-motivated with an internal locus of control. The external issues of what happens at college also have a huge impact on a student's success (Astin, 1993; Tinto, 2006-2007; Pascarella & Terenzini, 2005; Kuh, Kinzie, Schuh, & Whitt, 2005). As discussed in Chapters One and Three, I realise the limitations of only analysing the success of the students from a quantitative perspective. This was, however, the scope of this study. I know that a more comprehensive study is needed to reveal the influence of the issues discussed in Chapter Two. It is very important to know what determined the success of some students. These factors can then be enhanced. It is, however, also very necessary to determine what led to a number of students not succeeding. These issues can then also be addressed.

A finer categorisation of success such as excellent academic achievement, an average pass, a marginal pass, a just unsuccessful (almost passed) and a totally unsuccessful (definite fail) could perhaps have been more useful in this study. Success was defined as results obtained at the end of the first year in HE. From the start it was known not to be the ultimate measurement of success. Passing (or not) the first year of study cannot be seen as being successful or not. This point was chosen, however, because most of the students were still busy with their studies when this study was conducted. The end of year one is an important point to measure the progress of students, though. As indicated in section 2.4.2.1, large numbers of first-year students withdraw from or drop out of undergraduate courses internationally (Scott, 2009; Ross, 2010; Letseka, 2009; Kuh, Kinzie, Schuh & Whitt, 2005). If the problem can be assessed and hopefully successfully addressed at this crucial point, something can possibly also be done to stop this problem right there.

The comparison between former bridging programme students and their peers from the same schools and the same faculties in HE, further revealed the former bridging programme students performed on a par with their peers in the Faculties of Medicine and Health Sciences, AgriSciences and Social Sciences, but were outperformed by their peers from the same schools in the Faculties of Engineering, Economic and Management Sciences, and the Sciences. It will also be interesting and worthwhile to investigate how many of these students (in both groups) continued with their studies and ultimately graduated.

Although the results of this study were not conclusive enough to warrant changes in the selection process of the SciMathUS programme, the findings in this study and other related

studies with similar objectives indicate that this matter does merit further investigation. Some of these issues will be highlighted in the following sections.

5.3 Strengths of this study

1. One of the first positive outcomes of this study is that the majority of students finished SciMathUS with statistically significantly better results in Mathematics and Physical Sciences after attending the programme. Although it was not the purpose of this study to evaluate the programme, the big difference in performance of the group studied (19,8 percentage points more in NSC Mathematics and 21 percentage points more in Physical Sciences) cannot be ignored. The fact that the students managed to obtain these improved results within only a few months,[32] is also noteworthy. With good teaching and students taking responsibility for their own learning (see section 2.6), many more students in the South African education system would possibly be able to perform on a much higher level. This is something the teaching authorities should take note of.

2. This is a first attempt to analyse the performance of former SciMathUS students in HE (albeit only at Stellenbosch University) and compare their performance with mainstream students. The outcomes of this study could inform discussions and decisions about the existence of this specific programme and about bridging programmes in general. It certainly will be used in discussions with funders and prospective funders of this programme, one of the reasons why this study was undertaken (see section 1.2).

3. During the investigation of other bridging programmes, especially in South Africa, nothing else could be found in the national literature about SciMathUS, but the study by Malan (2008),[33] despite the programme being in operation since 2001. This study would like to make available information about a successful bridging programme in South Africa.

4. This study further investigated the predictive value of school results (and the performance in an alternative measurement tool) for the performance of students accessing HE via an alternative route. In doing so, this study could contribute towards the discussion on alternative access programmes and the debates about access for success, especially in South Africa.

5. Even though the Grade 12 and AT results did not appear to have predictive value for future academic performance for this group studied, a number of the students performed well in HE. This is a group of students who would not have had the opportunity to enrol in HE and be successful, had they not attended a bridging programme. Even though the

[32] February to October, since the students write the NSC examinations in October of each year.

[33] The focus was the development of an integrated problem-based learning (PBL) approach in SciMathUS.

concept of prior knowledge of Mathematics as a predictor of academic success in science-related courses should not be disregarded, as also argued by Van der Merwe and De Beer (2006) and Altink (1987), this study also confirms that success cannot be measured by pass rates only.

5.4 Limitations of this study

Some limitations of this study have been identified.

1. The sample of students who enrolled in HE and whose success in HE could be analysed was limited to the students who enrolled at Stellenbosch University. This made the sample rather small (n=179) and can therefore not be seen as a true reflection of the whole SciMathUS group. The outcomes of this study can therefore not be generalised. It does not claim to be applicable to other groups of students at other institutions.

2. It was not within the scope of this study to include qualitative aspects. Investigating success only from a quantitative perspective has its limitations. Success is too complex an issue. This was argued in detail in Chapter Three.

3. This study used averages and the results of groups only. It may be worthwhile to use these results to investigate the performance of individuals and the top achievers or the non-performers in more depth.

5.5 Recommendations for future research

Some of the recommendations for future studies have already been mentioned as part of the strengths and limitations of this study. The following are, however, also recommended.

1. Since there was no correlation between Grade 12 results or AT results, it would be interesting to know what motivated the students to succeed. It would be interesting and worthwhile to investigate the 'why' questions that informed this research in the first place, as indicated in Chapter One. Why are some students more successful than others? What are the factors that have an influence on their success?

2. If the argument about the predictive value of Grade 12 results for success in HE is to be investigated further, it would be interesting to analyse the successful students' full range of school results. This could also possibly bring more clarity on high or low scoring. In this study only the Mathematics and Physical Sciences results were used in the analyses.

3. The fact that no correlation could be found between the Grade 12 and AT results of the students who first attended a bridging programme and their performance at the end of

year one in HE should not be viewed negatively either. The findings of this study may assist the programme to investigate these issues in more depth.

4. Mathematics and Physical Sciences were used in this study as the Grade 12 results in the attempt to predict success in HE. These are two of the three core subjects offered by SciMathUS, as indicated in Chapter One. It might be of interest to add these improved results to the rest of the students' Grade 12 results and then redo these analyses.

5. It may also be worthwhile to investigate the qualitative issues influencing these students in being successful or not successful. The statistical analyses revealed that students with results of between 50% and 60% in Mathematics and Physical Sciences obtained averages of more than 60% at the end of year one in a BSc degree programme, which confirms the arguments of researchers such as Pascarella, Pierson, Wolniak and Terenzini (2004); Pascarella and Terenzini (2005); Tinto and Pusser (2006); Exner (2003); Astin (1999) as well as Kuh, Kinzie, Schuh and Whitt (2005) that there are many dimensions to success and many factors to be taken into consideration when the success of students is studied. According to Enslin, Button, Chakane, de Groot and Dison (2006) as well as Dweck (2010) and others, possibly the most crucial factor influencing success is motivation. Tinto and Pusser (2006) argue that success has to do with the integration of social and academic issues. Investigating this was not within the scope of this study, but an investigation combining the quantitative data of who passed and who not with the "why' questions would be very interesting. The fact that the study focused on a quantitative definition of success only was a definite limitation, as success is a rather complex issue. A study with a qualitative focus could add value to this study.

6. The comparison of the performance of the SciMathUS students and their peers in HE was not conducted to answer the research question directly. The analysis was done to achieve some homogeneity when the success of the former SciMathUS students in HE was analysed and interpreted and to create a context for the interpretation of the results of the former students. Without knowing how students performed in comparison with others, does not mean much. This analysis revealed interesting information worth investigating further, such as why did the bridging programme students perform better or on par in only three faculties, and why only in Medicine and Health Sciences, AgriSciences and Social Sciences? Why were they outperformed by their peers from the same schools in the Faculties of Engineering, Economic and Management Sciences, and the Sciences?

7. As discussed already, several studies have been conducted to determine the correlation between Grade 12 results and success in HE. More studies, however, are necessary to investigate the predictive value of the post-2008 Grade 12 results for success in HE.

8. In the analyses of the AT and NSC scores, it was found that the improvement in the AT was considerably lower than the improvement in the NSC scores. As already mentioned,

this is perhaps an indication that the school curriculum has changed so much that school-leaving students have been less prepared for HE after 2008.

9. In an attempt to achieve some form of homogeneity, the SciMathUS students' performance in HE was measured against the success of their peers who attended the same schools and who enrolled in the same faculties in HE at Stellenbosch University directly after school without attending SciMathUS. Because of the scope of this project, only the success rate of the bridging programme students was determined at the end of year one in HE. It could be worth investigating the correlation between these students' Grade 12 results and their HE results and compare this to the results obtained from the SciMathUS students. A further recommendation is therefore that it would be interesting to determine the success rate of the peer group at the end of year one and to compare that to the performance of the SciMathUS students. It would also be worthwhile to determine the success rate of the bridging programme students beyond year one in HE and compare that with their peers and with the throughput rate of students in general.

5.6 Reflections by the researcher

As indicated in Chapter One, my interest in access and success originates from being responsible for the marketing of, and fundraising for SciMathUS at Stellenbosch University in South Africa for the past 10 years. A number of people were interested in the performance of the students after they have completed SciMathUS: funders and all of us involved in the programme. Although this study only investigated the performance or success of a group of former SciMathUS students at the end of their first year in HE at Stellenbosch University, this is a first attempt to analyse the performance of the students beyond the programme. The life-changing stories told by the students can now be strengthened with facts.

The question, with which the SciMathUS programme was confronted since its inception in 2001, was how to select the candidates who are most likely to succeed in HE. The assessment of potential is a complex issue (Jarvis J. M., 2009). I was challenged by statements which claimed, for example, that selecting 'at-risk' students for a science-orientated programme is "fraught with complexity" (Rollnick, 2010, p. 84) and that taking contextual factors into consideration to improve the efficiency of their selection "is an inexact science and relies on the extensive experience of those engaged in selection" (Rollnick, 2010, p. 84). These are the issues experienced in the programme every year during the selection process. By embarking on this quantitative journey, I had hoped to find an answer to assist us in this process. If the pass rates or standards of the successful students could be applied when new applications were considered, this would make the process much easier.

Engaging in the debates offered by renowned researchers in many articles was an enriching experience. It also prepared the realisation that a number cannot do justice to the issue of who

is defined as successful. When the analyses revealed no correlation between the Grade 12 results and the AT results and performance in HE, it was a relief to a certain extent. The fact that students with average Grade 12 marks in Mathematics and Physical Sciences (between 50% and 60%) performed well in HE, and students with excellent marks in the same subjects obtained average marks in HE, indicates that predicting the academic achievement of any student is a complex issue. I trust that the findings of this study will be able to make a contribution to the continuous debates about selection and success we have in the programme.

5.7 Concluding remarks

According to Rollnick (2010), the question that remains to be answered is what is perceived as a good predictor of success. Should alternative testing measurements, including aptitude and ability tests, as suggested by Altink (1987), be considered as a pre-entry selection measurement? To base admission strictly on test scores and grades ignores the fact that other factors may have an impact on performance. Should background and contextual factors be taken into consideration? There is still a debate about how these factors affect academic performance. The assumption behind considering background and contextual factors is that these factors may have a negative impact on learning and therefore on success. If these factors were to be taken into consideration, how should this be done?

The use of additional tests as part of the selection criteria is an effort to 'correct' for the unequal schooling in South Africa (Van der Merwe & de Beer, 2006). Unfortunately, using these tests is not the ultimate solution either, as the quality of schooling also influences performance in these tests. Obviously attending HE is about building on previous education too, but if the foundations are wrong, that should be addressed. South Africa's education system is failing generations of children. If a student attending a bridging programme is able to improve his or her Mathematics results by more than 50 percentage points within a few months, there is reason for concern about the quality of the school education. Why could he or she not achieve those results in the first place? There is, however, also reason to celebrate. That student is now able to gain access to HE. Access, however, is not something that can be given to a student. Epistemological access entails learning how to become a successful participant in an academic practice (Morrow, 2009). There are many things that might help a student to do this more effectively. The student has to have particular characteristics, sufficient resources (finances, facilities and books) and has to be in the company of other serious students, actively engaged in the learning process. There should also be positive institutional conditions, such as good facilities and resources, and the sympathetic support of good teachers allowing students to be learners. "But all of these things can, at best, only facilitate, and never guarantee my epistemological access; I must be trying to learn. It is essentially dependent on what I do" (Morrow, 2009). Or in the words of Tinto and Pusser

(2008), “[T]he more students learn and value their learning, the more likely they are to stay and graduate” (p. 8).

6 Works Cited

Abrandt Dahlgren, M., & Dahlgren, L. (2002). Portraits of PBL: students' experiences of the characteristics of problem-based learning in physiotherapy, computer engineering and psychology. *Instructional Science, 30,* 111–127.

Akoojee, S., & Nkomo, M. (2007). Access and quality in South African higher education: the twin challenges of transformation. *South African Journal of Higher Education, 21*(3), 385-399.

Altink, W. M. (1987). The evaluation of selection tests for educational upgrading programmes in Botswana and Swaziland. *International Journal of Educational Development, 7*(1), 1-12.

American Sociological Association. (2012). *About.com/ Education/ Sociology/ Research and Methodology/ Ethical Considerations In Sociological Research*. Retrieved from Ethical Considerations in Sociological Research: Five principles of the American Sociological Association's Code of Ethics: http://sociology.about.com/od/Research/a/Ethics.htm

Anastasi, A., & Urbina, S. (1997). *Psychological Testing.* Upper Saddle River: Prentice-Hall Inc.

Astin, A. W. (1993). *What matters in college? Four Critical Years revisted.* San Francisco: Jossye-Bass Inc.

Babbie, E., & Mouton, J. (2011). *The practice of social research.* Cape Town: Oxford University Press.

Bathembu, C. (2009, October 20). *South Africa.info*. Retrieved from South Africa.info: education: http://www.southafrica.info/services/education/matric-200909.htm#ixzz1pvJLfMlQ

Belanger, P., & Tuijnman, A. (1997). *New patterns of adult learning: a six-country comparative study*. Oxford: Elsevier.

Bird, A. (2011, August 11). *"Thomas Kuhn", The Stanford Encyclopedia of Philosophy (Winter 2011 Edition), Edward N. Zalta (ed.)*. Retrieved from http://plato.stanford.edu/entries/thomas-kuhn/#3: http://plato.stanford.edu/entries/thomas-kuhn/#3

Black, T. R. (1999). *Doing quantitative research in the socialsSciences: An Integrated Approach to Research Design, Measurement and Statistics.* London, Thousand Oaks, New Delhi: SAGE.

Botha, A. E., McCrindle, C. M., & Owen, J. H. (2003). Mathematics at matriculation level as an indicator of success or failure in the 1st year of the Veterinary Nursing Diploma at the Faculty of Veterinary Science, University of Pretoria. *Journal of the South African Veterinary Association, 74*(4), 132–134.

Bothma, A., Botha, H. L., & Le Roux, N. J. (2004). School results and access test results as indicators of first year performancec at university. *Orion, 20*(1), 73–88.

Briggs, A. R., Clark, J., & Hall, I. (2012). Building Bridges: Understanding Student Transition to University. *Quality in Higher Education, 18*(1), 3 – 21.

Brunel University. (2012). *http://www.brunel.ac.uk/about/administration/access-and-widening-participation*. Retrieved from http://www.brunel.ac.uk: http://www.brunel.ac.uk

Chutgar, A., & Kanjee, A. (2009). School money: funding the flaws. *HSRC Review, 7*(4), 18-19.

Claxton, G. (1990). *Teaching to learn - a direction for edcuation.* London: Cassell Education Limited.

Cliffordson, C. (2008). Differential Prediction of Study Success Across Academic Programs in the Swedish Context: The Validity of Grades and Tests as Selection Instruments for Higher Education. *Educational Assessment, 13*, 56–75.

Cosser, M., & Sehlola, S. (2009). *Ambitions revised: Grade 12 learner destinations one year on.* Cape Town: HSRC Press.

Coughlan, F. (2006). Access for success. *South African Journal of Higher Education, 20*(2), 209-218.

Council for Higher Education. (2006). *Access and Throughput in South African Higher Education: three case studies: HE Monitor No.9.* Council on Higher Education. CHE.

Council on Higher Education (CHE). (2000). *Towards a new higher education landscape.* Council on Higher Education.

Council on Higher Education (CHE). (2010). *Teaching and Learning beyond Formal Access: Assessment through the Looking Glass: HE Monitor No.10.* Pretoria: Council on Higher Education.

Council on Higher Education (CHE). (2012). *Comment on the Green Paper for Post-Education and Training.* CHE.

Council on Higher Education. (2004). *South African Higher Education in the first decade of democracy.* Pretoria: The Council on Higher Education.

Creswell, J. W. (2009). *Research design: qualigtative, quantitative and mixed method approaches.* Thousand Oaks, California: SAGE Publications, Inc.

Criteria Corporation. (2012). *Criteria Corporation.* Retrieved from Web-based Pre-Employment Testing Software-as-a-Service (SaaS).

Department of Basic Education. (2012). *Department of Basic Education.* Retrieved from www.education.gov.za

Department of Basic Education. (2012). *EMIS data*. Retrieved from Department of Basic Education: http://www.education.gov.za/EMIS/EMISDownloads/tabid/466/Default.aspx

Department of Education. (1998). *National Norms and Standards for School Funding in terms of the South African Schools Act, 1996 (Act no. 84, 1996).* Pretoria: Department of Education.

Department of Education. (2004). *Creating comprehensive universities in South Africa: a concept document.* Pretoria: Department of Education.

Department of Education. (2005 (revised in 2008)). *Higher Education Act, 1997 (Act 101 of 1997). Minimum admission requirements for Higher certificate, diploma and bachelor's degree programmes.* Pretoria: Department of Education.

Department of Education. (2005). *Conceptual and operational guidelines for the implementation of inclusive education: special schools as resource centres.* Pretoria: Department of Education.

Department of Education. (2007). *Trends in Education Macro Indiacators: South Africa.* Pretoria: Department of Education.

Department of Health and Human Services, & National Institutes of Health. (2012, September 24). *HRPP: Human Research Protections programme*. Retrieved from Human Subjects Research Protections: http://ohsr.od.nih.gov/

Department of Higher Education and Training (DHET). (2012). *Green Paper for Post-School Education and Training.* Pretoria: Department of Higher Education and Training.

Dirkx, J. M. (2001). The power of feelings: emotion, imagination, and the construction of meaning in adult learning. In S. B. Merriam, *New directions for adult and continuing education* (Vol. 89, pp. 63-72). Jossey-Bass, a publishing unit of John Wiley & sons, Inc.

Dolmans, D. H., Wolfhagen, I. H., van der Vleuten, C. P., & Wijnen, W. H. (2001). Solving problems with group work in problem-based learning: hold on to the philosophy. *Medical Education, 35*, 884-889.

Downs, C. T. (2005). Is a year-long access course into university helping previously disadvantaged black students in biology? *South African Journal of Higher Education, 4*, 666-683.

Du Plessis, L., & Gerber, D. (2012). Academic preparedness of students – an exploratory study. *Td The Journal for Transdisciplinary Research in Southern Africa, 8*(1), 81-94.

Dursan, D. (2012). Predicting student attrition with data mining methods. *Journal of College Student Retention, 13*(1), 17-35.

Dweck, C. S. (2010). Mindsets and Equitable education. *Principal Leadership, January 2010*, 26-29.

Eiselen, R., Strauss, J., & Jonck, B. (2007). A basic mathematical skills test as predictor of performance at tertiary level. *South African Jourrnal of Higher Education, 21*(1), 38–49.

Enslin, P. A., Button, A., Chakane, M., de Groot, M., & Dison, L. (2006). Assessing academic potential for university admission: the biographical questionnaire. *South African Journal of Higher Education, 20*(4), 433-488.

Evans, M. (2000). Planning for the Transition to Tertiary Study: A Literature Review. *Australasian Association for Institutional Research, 9*(1).

Exner, R. J. (2003). *The identification of psych-educational factors that inhibit first year student performance.Thesis submitted in accrordance wiht the requrements for the degree of Doctor in Education in Psychology of Education.* Pretoria: University of South Africa.

Fastre, G., Gijselaers, W. H., & Segers, M. (2008). Selection to Ensure Study Success: Looking for Multiple Criteria in the Case of a European Master of Science Program in Business. *Journal of Education for Business, Sept/Oct 2008*, 47-54.

Fernando, N., Prescott, G., Cleland, J., Greaves, K., & McKenzie, H. (2009). A comparison of the United Kingdom Clinical Aptitude Test (UK-CAT) with a traditional admission selection process. *Medical Teacher, 31*, 1018–1023.

Gephart, R. (1999). Paradigms and Research Methods. *Research Methods Forum, 4*. Academy of Management, Research Methods Division.

Gibbon, T. (2009). Weighing success and diversity in the balance at Stellenbosch University. In M. Letseka, M. Cosser, V. Breier , & M. Visser, *Student Retention and Graduate Destination: Higher Education and Labour Market Access and Success* (pp. 67-85). Pretoria: HSRC.

Giuliano, B., & Sullivan, J. (2007). Academic wholism: bridging the gap between High school and college. *American Secondary Education, 35*(3), 7-18.

Glass, B. (1965). The Ethical Basis of Science. *Science, New Series Published by: , 150*(3701), 1254-1261.

Gorard, S. (2001). *Quantitative methods in Educational research. The role of numbers made easy.* London and New York: Continuum.

Gorard, S. (2010). Research Design, as Independent of Methods. In S. Gorard, *Handbook of Mixed Methods 2010* (pp. 1-24). London: http://ebookbrowse.com/gorard-handbook-of-mixed-methods-2010-pdf-d61357902. Retrieved from http://eprints.bham.ac.uk/514/1/Gorard_Handbook_of_Mixed_Methods_2010.pdf

Gorard, S., & Taylor, C. (2004). *Combining Metods in Educational and Social Research.* Berkshire: Open University Press.

Grayson, D. J. (2010). *Design of the engineering augmented degree programme at the University of Pretoria.* http://www.assaf.org.za/wp-content/uploads/2010/10/Grayson-Engineering-Augmented-Degree.pdf.

Griesel, H. (1999, updated 2000). *Access and the Higher Education sector: a South African case study on policy and programme achievement.* Pretoria: Association for the Development of Education in Africa (ADEA) & South African National Department of Education (DoE).

Griesel, H. (2003). Controversies of access to HE study – the changing Further Education and Higher Education interface. *Paper prepared for the 21st Annual AEAA Conference, 25-30 August.* Cape Town.

Griesel, H., & Parker, B. (2009). *Graduate attributes: a baseline study on South African graduates from the perspective of employers Higher Education.* Pretoria: South Africa & The South African Qualifications Authority.

Guba, E. G., & Lincoln, Y. S. (1994). Competing paradigms in qualitative research. In N. K. Denzin, & Y. S. Lincoln, *Handbook of qualitative research* (6 ed., Vol. 2, pp. 105-117). Thousand Oaks: Sage Publications.

Gukas, I. D., Leinster, S., & Walker, R. (2010). Verbal and nonverbal indices of learning during problem-based learning (PBL) among first year medical students and the threshold for tutor interventionr. *Medical Teacher, 32*, e5–e11.

Hanson, W. E., Creswell, J. W., Plano Clark, V. L., Petska, K. S., & Creswell, J. D. (2005). Mixed Methods Research Designs in Counseling Psychology. *American Psychological Association Journal of Counseling Psychology, 52*(2), 224–235.

Higher Education South Africa (HESA). (2011). *Key data on Higher Education in South Africa*. Retrieved from http://www.hesa.org.za/sites/hesa.org.za/files/11%20821%20-%20HESA%20Data%20Card%20WEB.PDF

Jacobs, M. (2010). *A framework for the placement of university students in science programmes: Ph.D thesis.* Bloemfontein: The School of Higher Education Studies, Faculty of Education, Uniiversity of the Free State.

Jarvis, J. M. (2009). Planning to unmask potential through responsive curriculum: the "famous five" exercise. *Roeper Review, 31*, 234-241.

Jarvis, P., Holford, J., & Griffin, C. (1998). *The theory and practice of learning.* London: Kogan Page Limited.

Johnson , R. B., & Onwuegbuzie, A. J. (2004). Mixed Methods Research: A Research Paradigm Whose Time Has Come. *Educational Researcher, 33*(7), 14-26.

Kennet, D. J., & Reed, M. J. (2009). Factors influencing academic success and retention following a 1st-year post-secondary success course. *Educational Research and Evaluation, 15*, 153-166.

Kieser, J., Herbison, P., & Harland, T. (2005). The influence of context on students' approaches to learning: a case study. *European Journal of Dental Education, 9*, 150–156.

King's College London. (2012). *http://www.kcl.ac.uk/prospectus/undergraduate/index/name/emdp/alpha/MNO/header_search/*. Retrieved from http://www.kcl.ac.uk: http://www.kcl.ac.uk

Klopfenstein, K., & Thomas, M. K. (2009). The link between Advanced Placement Experience and early college success. *Southern Economic Journal, 75*(3), 873-891.

Koch, E. (2007). Critical questions about the new entrance test for higher education. *South African Journal of Higher Education, 21*(1), 102-111.

Kugelmass, J. (2006). *Constructivist views of learning: implications for inclusive education.* Retrieved March 5, 2010, from http://sage-ereference.com/hdbk_specialedu/Article_n21.html

Kuh, G. D., Kinzie, J., Buckley, J. A., Bridges, B. K., & Hayek, J. C. (2006). *Report for the National Symposium on Postsecondary Student Success: Spearheading a Dialog on Student Success.* National Postsecondary Education Cooperative.

Kuh, G. D., Kinzie, J., Schuh, J. H., & Whitt, E. J. (2005). *Student Success in College: creating conditions that matter.* San Francisco: Jossey-Bass.

Lee, M. F. (2010). *Inventory of Access Programs. International Examples of Practice in Increasing Post-Secondary Participation.* London: European Access Network.

Letseka, M. (2009). University drop-out and researching (lifelong) learning at work. In M. Letseka, M. Cosser, M. Breier, & M. Visser, *Student Retention and Graduate Destination: Higher Education and Labour Market Access and Success* (pp. 88-105). Pretoria: HSRC.

Letseka, M., Cosser, M., Breier, M., & Visser, M. (2010). *Student retention and graduate destination: higher education and labour market access and success.* Cape Town: HSRS Press.

Lincoln, Y. S., Lynham, S. A., & Guba, E. G. (2011). Paradigmatic controversies, contradictions and emerging confluences, revisited. In N. K. Denzin, & Y. S. Lincoln, *SAGE handbook of Qualitative Research* (4 ed., pp. 97-128). Thousand Oaks: Sage Publications.

Lowis, M., & Castley, A. (2008). Factors affecting student progression and achievement: prediction and intervention. A two-year study. *Innovations in Education and Teaching International, 45*(4), 333–343.

Mabila, T. E., Malatje, S. E., Addo-Bediako, A., Kazini, M. M., & Mathabatha, S. S. (2006). The role of foundation programmes in science education: The UNIFY programme at the University of Limpopo, South Africa. *International Journal of Educational Development, 26*(2), 295-304.

Maharajh, R., Motala, E., & Scerri, M. (2011). South Africa: Reforming Higher Education and Transforming the National System of Innovation. In B. Göransson, & C. Brundenius, *Universities in Transition: The Changing Role and Challenges for Academic Institutions* (p. Chapter 10). Ottowa, Canada: Springer: International Development Research Centre.

Malan, S. B. (2008). *The development of an integrated problem-based learning (PBL) approach in a post-matriculation programme at the University of Stellenbosch:*. Stellenbosch: submitted to the Department of Educational Phychology of the University of Stellenbosch in fulfillment of the requirements for the degree of Doctor of Philosophy.

Maree, J. G., Pretorius, A., & Eiselen, R. (2003). Predicting success among first-year Engineering students at The Rand Afrikaans University. *Psychological Reports*(93), 399-409.

Merriam, S. B., & Caffarella, R. S. (2007). Learning in Adulthood: A Comprehensive Guide,. (3). San Francisco: Wiley.

Mertens, D. M. (2005). *Research and evaluation in Education and Psychology. Integrating diversity with quantitative, qualitative and mixed methods: 2nd edition.* Thousand Oaks: SAGE Publications.

Morris, M. (2009, September 14 – 27). National Benchmark Tests create a stir – and a small storm. *Monday Paper, Newspaper of the University of Cape Town, 28*(13), p. 1.

Morrow, W. (2009). *Bounds of Democracy Epistemological Access in Higher Education.* Pretoria: HSRC Press.

Müller, A., & Van Wyk, C. (2012). Using quantitative methods to measure the impact of selected variables on student achievement in higher education: preliminary findings. *Conference on the Scholarship of Teaching and Learning.* Somerset West: Stellenbosch University.

Nair, P. A. (2002). A theoretical framework for an access programme encompassing further education training : remedy for educational wastage? *South African Journal of Higher Education, 16*(2), 94-03.

National Youth Development Agency. (2012). *National Youth Development Agency*. Retrieved from http://www.nyda.gov.za: http://www.nyda.gov.za

Naumann, W. C., Bandalos, D., & Gutkin, T. B. (2003). Identifying variables that predict college success in first generation college student. *The Journal Of College Admission, Fall*, 4-11.

Negash, Z., Olusola, O., & Colucci, E. (2011). *Access To Success: Project Compendium Part 2b: Access, Participation And Retention In Africa: Evidence from a survey on tertiary institutions.* Brussels: The European University Association.

Nel, C., & Kistner, L. (2009). The National Senior Certificate: Implications for access to higher education. *South African Journal of Higher Education, 23*(5), 953–973.

Neuman, W. L. (2000). *Social research metods: qualitative and quantitative approaches.* Needham Heights: A Pearson Education Company.

Nuutila, E., Törma, S., & Malmi, L. (2005, June). PBL and Computer Programming — The Seven Steps Method with Adaptations. *Computer Science Education, 15*, 123 – 142.

Ogunlana, O. (2010). African student perspectives on access and retention: the AASU perspective on access, diversity and retention challenges in Africa. In The European University Association, *Access to Success: fostering trust and exchange between Europe and Africa.*

Osborne, B., & Shuttleworth, I. (2004). Widening Access to Higher Education in the UK: Questioning the Geographic Approach. *Higher Education Management and Policy Widening Access to Higher Education in the UK: Questioning the Geographic Approach B Osborne I Shuttleworth, 16*(1), 101-118.

Osborne, M. (2003). Policy and practic in widening particpation: a six country compartive study of access as flexilbility. *International Jounral of Lifelong Education, 22*(1), 45-56.

Pascarella, E. T., Pierson, C. T., Wolniak, G. C., & Terenzini, G. T. (2004). First-Generation College Students: Additional Evidence on College Experiences and Outcomes. *The Journal of Higher Education, 75*(3), 249-284.

Pascarella, E., & Terenzini, P. (2005). *How college affects students: Findings and insights from twenty years of research.* San Francisco: Jossey-Bass.

Pokorny, M., & Pokorny, H. (2005). Widening participation in higher education: student quantitative skills and independent learning as impediments to progression. *International Journal of Mathematical Education in Science and Technology, 36*(5), 445–467.

Potgieter, M., Davidowitz, B., & Venter, E. (2010). Grade 12 achievement rating scales in the new National Senior Certificate as indication of preparedness for tertiary chemistry. South African Journal of Chemistry, 63, 75–82. *South African Journal of Chemistry, 63*, 75–82.

Ramrathan, P., Manik, S., & Pillay, G. (2007). Transformational access: The Upward Bound Programme as a possibility for promoting access to Higher Education. *South African Journal of Higher Education, 4*, 733–752.

Reddy, P. A., & Moores, E. (2008). Widening Access to Higher Education: An evaluative case study of a foundation year alternative to Access. *Psychology Teaching Review, 14*(1).

Reddy, T. (2004). *Higher education and social transformation: South Africa Case Study.* Cape Town: Council on Higher Education (CHE).

Resnik, D. B. (1998). *The ethics of science - an introduction.* London and New York: Routledge.

Rollnick, M. (2010). Selection and the Identification of Potential. In M. Rollnick, *Identifying Potential for Equitable Access to Tertiary Level Science.* Springer.

Ross, E. (2010). Selection tests and social justice: a profile of applicants seeking admission to the social work undergraduate degree at a South African University. *Social Work Education, 29*(5), 459–474.

Ryan, A. (2006). Post-positivist approaches to research, in (2006). In M. Antonesa, H. Fallon, A. B. Ryan, A. Ryan, T. Walsh, & L. Borys, *Researching and writing your thesis: a guide for postgraduate students* (pp. 12-28). Maynooth: MACE.

Schöer, V., Ntuli, M., Rankin, N., Sebastiao, C., & Hunt, K. (2010). A blurred signal? The usefulness of National Senior Certificate (NSC) Mathematics marks as predictors of academic performance at university level. *Perspectives in Education, 28*(2), 9–18.

Schreiner, L., & Hulme, E. (2009). Assessments of students' strenghts: the first step to student success. In B. Leibowitz, A. Van der Merwe, & S. Van Schalkwyk, *Focus on first-year success: perspectives emerging from South Africa and beyond* (pp. 69-78). Stellenbosch: SUN MeDIA.

Schunk, D. H., & Pajares, F. (2005). Competence perceptions and academic functioning. In A. J. Elliot, & C. S. Dweck, *Handbook of Competence and Motivation* (pp. 85-104). New York: The Guilford Press.

Schwartz, S. (2004). *Fair admissions to higher education: recommendations for good practice.* Nottingham: Department for Education and Skills Publications.

Scott, I. (2009). Towards an Agenda for SoTL in Africa? *International Journal for the Scholarship of Teaching and Learning, 3*(1), 1-8.

Scott, I., Yeld, N., & Hendry, J. (2007). *Higher Education Monitor A Case for Improving Teaching and Learning in South African Higher Education Council on Higher Education* . Cape Town: Centre for Higher Education Development University of Cape Town.

Scott, T., Tolson, H., & Huang, T.-Y. (2010). Assessment of Advanced Placement Participation and University Academic Success in the first semester: controlling for selected high school academic abilities. *Journal of College Admission,* 25-30.

Scott, T., Tolson, H., & Huang, T.-Y. (2011). Haunted by high school performance no more. *Journal of College Admission*.

Smit, J. H. (2011). Director, Institute for Mathematics and Science Teaching, Stellenbosch University. (A. Müller, Interviewer)

Soudien, C. (2008). *Report of the Ministerial Committee on Transformation and Social Cohesion and the Elimination of Discrimination in Public Higher Education Institutions.* Pretoria: Department of Education.

Spaull, N. (2012). Education in South Africa: a tale of two systems. *Politicsweb*.

Steenkamp, L., Baard, R., & Frick, L. (2009). Focus on first-year success: perspectives emerging from South Africa and beyond. In B. Leibowitz, A. Van der Merwe, & S. Van Schalkwyk, *Student perceptions of the factors influencing their success in first year accounting* (pp. 143-154). Stellenboch: SUN MeDIA.

Stellenbosch University. (2012). *Stellenbosch University*. Retrieved from Stellenbosch University: http://shortcourses.sun.ac.za/.

Stenden University. (2012). *http://www.stenden.com*. Retrieved from http://www.stenden.com/en/locations/qatar/aboutstendenuniversityqatar/Studeis/Pages/Academicbridgeprogramme.aspx: http://www.stenden.com

Straw, W. (2003). Education for all - widening access to higher education. *Eeducation review, 16*(2), 34 - 38.

Su, Y. (2011). Lifelong Learning as Being: The Heideggerian Perspective. *Adult Education Quarterly, 1*, 57–72.

Taal, A. B. (2011). *What missions, what strategies and what approaches to be assigned to the African university of the 21st century? What university to support development efforts of African governments in order to achieve the status of emerging countries?* Rabat, Marocco: Conference on the role and place of the university in the Africa of the 21st Century.

Tan, O. S. (2004). Students' experiences in problem-based learning: three blind mice episode or educational innovation? *Innovations in Education and Teaching International, 41*(2), 169-184.

Tashakkori, A., & Teddlie, C. (2003). *Handbook of mixed methods in social and behavioral research.* Thousand Oaks: SAGE Publications.

Taylor, E. W. (2010). Transformative learning theory: a neurobiological perspective of the role of emotions and unconscious ways of knowing. *International Journal of Lifelong Education, 20*(3), 218 – 236.

Taylor, S. (2010). *Uncovering indicators of effective school management in South Africa using the National School Effectiveness Study.* Stellenbosch: Stellenbosch Economic Working Papers: 10/11.

TechTarget. (2000-2012, March). *SearchCRM*. Retrieved from SearchCRM: http://searchcrm.techtarget.com /definition/knowledge-worker

The European University Association. (2010). *Access to Success: fostering trust and exchange between Europe and Africa.* Brussels: The European University Association.

The United States Holocaust Memorial Museum. (2012, September 24). *The United States Holocaust Memorial Museum*. Retrieved from The United States Holocaust Memorial Museum: http://www.ushmm.org/research/doctors/Nuremberg_Code.html

Thomas, L., Jones, R., & May, H. (2010). Literature review: a research-informed approach to improving institutional retention. In The European University Association, *Access to success: fostering trust and exchange between Europe and Africa* (pp. 33-44).

Tierney, W. G., Colyar, J. E., & Corwin, Z. B. (2003). *Preparing for college, building expectations, changing realities.* Los Angeles: Centre for Higher Education Policy Analysis, Rossier School of Education, University of Southern California.

Tinto, V. (2006-2007). Research and practice of student retention: what next? *Journal of College Student Retention, 8*(1), 1-19.

Tinto, V., & Pusser, B. (2006). *Moving from theory to action: buidling a model of institiutional action for student success.* National Postsecondary Education Cooperative.

Trapmann, S., Hell, B., Hirn, J. W., & Schuler, H. (2007). Meta-Analysis of the Relationship Between the Big Five and Academic Success at University. *Journal of Psychology, 215*(2), 132–151.

U.S. Department of Health & Human Services. (2012, September 24). *U.S. Department of Health & Human Services*. Retrieved from U.S. Department of Health & Human Services: http://www.hhs.gov/index.html

Umalusi. (2010). *Directives For Certification: National Senior Certificate (Schools).* http://www.umalusi.org.za/ur/publications/20101101DirectivesNSC.pdf: Umalusi: Council for Quality Assurance in General.

UNESCO. (1995-2012). *WORLD DECLARATION ON HIGHER EDUCATION FOR THE TWENTY-FIRST CENTURY: VISION AND ACTION*. Retrieved from UNESCO: http://www.unesco.org/education/educprog/wche/declaration_eng.htm

United Nations (UN). (no date). *The Universal Declartion of Human Rights*. Retrieved from The Universal Declartion of Human Rights: http://www.un.org/en/documents/udhr/

University of East London. (2012). *http://www.uel.ac.uk/cass/shortcourses/nb2/*. Retrieved from http://www.uel.ac.uk/: http://www.uel.ac.uk/

USA Congressional Commission. (1979). *The Belmont Report: Ethical Principles and Guidelines for the Protection of Human Subjects of Research.* USA Congressional Commission and retrieved from http://archive.org/stream/belmontreporteth00unit#page/n17/mode/2up.

Van der Flier, H., Thijs, G. D., & Zaaiman, H. (2003). Selecting students for a South African mathematics and science foundation programme: the effectiveness and fairness of school-leaving examinations and aptitude tests. *International Journal of Educational Development, 23*, 399–409.

Van der Merwe, D., & de Beer, M. (2006). Challenges of student selection: predicting academic performance. *South African Journal of Higher Education, 20*(4), 547–562.

Visser, A. J., & Hanslo, M. (2005). Approaches to predictive studies: Possibilities and challenges. *South African Journal of Higher Education, 19*(6), 1160–1176.

Wagner-Welsh, J. (2008). *The Identification of Criteria to be utilised in Mathematical Diagnostic Tests.* Submitted in fulfilment of the requirements for the degree of Philosophiae Doctor in the Faculty of Science at the Nelson Mandela Metropolitan University.

Weisstein, E. W. (2012, 09 25). *"Correlation." From MathWorld--*. . Retrieved from A Wolfram Web Resource: http://mathworld.wolfram.com/Correlation.html

Yeld, N., & Haeck, W. (1997). Educational Histories and Academic Potential: can tests deliver? *Assessment & Evaluation in Higher Education, 22*(1), 5-16.

Zaaiman, H., Van Der Flier, H., & Thijs, G. D. (2000). Selection as contract to teach at the student's level. Experiences from a South African mathematics and science foundation year. *Higher Education, 40*, 1–21.

7 Addenda

iwwous
imstus

20 Maart 2012

Universiteit Stellenbosch
STELLENBOSCH

Geagte heer/dame

AANBEVELING: GEBRUIK VAN INLIGTING UIT UNIVERSITEITSDATABASISSE

Hiermee beveel ek aan dat daar aan me Anneke Müller, werknemer van IWWOUS, toestemming verleen word om SciMathUS-data uit die Universiteitsdatabasis vir navorsingsdoeleindes te gebruik. Die data wat ter sprake is, is die 2008 – 2011 SciMathUS graad 12-punte en TGT-resultate asook die HEMIS krediete van die voormalige SciMathUS-studente wat by die Universiteit van Stellenbosch ingeskryf het.

Vriendelik die uwe

Dr Kosie Smit
DIREKTEUR: IWWOUS

UNIVERSITEIT·STELLENBOSCH·UNIVERSITY
jou kennisvennoot • your knowledge partner

Instituut vir Wiskunde- en Wetenskaponderwys / Institute for Mathematics and Science Teaching
Departement Kurrikulumstudie, Fakulteit Opvoedkunde / Department of Curriculum Studies, Faculty of Education
Universiteit • Stellenbosch • University
Privaatsak/Private Bag X1, 7602 Matieland
Tel: 021 808 3483, Faks/Fax: 021 808 3000 • www.imstus.sun.ac.za

UNIVERSITEIT • STELLENBOSCH • UNIVERSITY
jou kennisvennoot • your knowledge partner

17 Mei 2012

Mev. A. Müller
Instituut vir Wiskunde- en Wetenskaponderwys
Fakulteit Opvoedkunde
Universiteit Stellenbosch

Geagte mev. Müller,

Insake navorsingsprojek: ***Analysing the pre and post scores of students in a bridging programme***

Hiermee word institusionele toestemming verleen dat die navorser toegang mag kry tot die institusionele data van die betrokke SciMathUS studente vir die doel van die bogenoemde navorsingsprojek.

Hierdie toestemming is onderhewig aan die vereistes dat die persoonlike besonderhede van die betrokke studente ten alle tye beskerm word, en dat die studente anoniem moet bly.

Jan Botha
Senior Direkteur Institusionele Navorsing en Beplanning

Afdeling Institusionele Navorsing en Beplanning • Institutional Research and Planning Division
Privaatsak/Private Bag X1 • Stellenbosch • 7602 • Suid-Afrika/South Africa
Tel. + 27 21 808 3967 • Faks/Fax + 27 21 808 4533

UNIVERSITEIT·STELLENBOSCH·UNIVERSITY
jou kennisvennoot • your knowledge partner

Approved with Stipulations
New Application

08-May-2012
Muller, Anneke A

Protocol #: HS794/2012
Title: Predictive validity of grade 12 results and university access tests for success in higher education

Dear Mrs. Anneke Muller,

The **New Application** received on **23-Apr-2012**, was reviewed by Research Ethics Committee: Human Research (Humanities) via Committee Review procedures on **26-Apr-2012**.

Please note the following information about your approved research protocol:

Protocol Approval Period: **26-Apr-2012 -25-Apr-2013**

Present Committee Members:
Horn, Lynette LM
Theron, Carl CC
Prozesky, Heidi HE
Hansen, Leonard LD
Somhlaba, Ncebazakhe NZ
Mostert, Paul PJ
Fouche, Magdalena MG
Van Wyk, Berte B
Van Zyl, Gerhard Mkhonto
Engelbrecht, Sidney SF
De Villiers-Botha, Tanya T
De Villiers, Mare MRH
Bitzer, Elias EM

The Stipulations of your ethics approval are as follows:
1. The researcher acknowledges, through the submission of the copy of a letter sent to Prof Jan Botha, that a copy of the letter of institutional permission to conduct research on students is required. This letter, as soon as it becomes available, should be forwarded to the REC before the study commences.

Standard provisions
1. The researcher will remain within the procedures and protocols indicated in the proposal, particularly in terms of any undertakings made in terms of the confidentiality of the information gathered.
2. The research will again be submitted for ethical clearance if there is any substantial departure from the existing proposal.
3. The researcher will remain within the parameters of any applicable national legislation, institutional guidelines and scientific standards relevant to the specific field of research.
4. The researcher will consider and implement the foregoing suggestions to lower the ethical risk associated with the research.

You may commence with your research with strict adherence to the abovementioned provisions and stipulations.

Please remember to use your **protocol number** (**HS794/2012**) on any documents or correspondence with the REC concerning your research protocol.

Please note that the REC has the prerogative and authority to ask further questions, seek additional information, require further modifications, or monitor the conduct of your research and the consent process.

After Ethical Review:
Please note that a progress report should be submitted to the Committee before the approval period has expired if a continuation is required.
The Committee will then consider the continuation of the project for a further year (if necessary). Annually a number of projects may be selected randomly for an external audit.

National Health Research Ethics Committee (NHREC) number REC-050411-032.

This committee abides by the ethical norms and principles for research, established by the Declaration of Helsinki, the South African Medical Research Council Guidelines as well as the Guidelines for Ethical Research: Principles Structures and Processes 2004 (Department of Health).

Provincial and City of Cape Town Approval

Please note that for research at a primary or secondary healthcare facility permission must be obtained from the relevant authorities (Western Cape Department of Health and/or City Health) to conduct the research as stated in the protocol. Contact persons are Ms Claudette Abrahams at Western Cape Department of Health (healthres@pgwc.gov.za Tel: +27 21 483 9907) and Dr Helene Visser at City Health (Helene.Visser@capetown.gov.za Tel: +27 21 400 3981). Research that will be conducted at any tertiary academic institution requires approval from the relevant parties. For approvals from the Western Cape Education Department, contact Dr AT Wyngaard (awyngaar@pgwc.gov.za, Tel: 0214769272, Fax: 0865902282, http://wced.wcape.gov.za).

Institutional permission from academic institutions for students, staff & alumni. This institutional permission should be obtained before submitting an application for ethics clearance to the REC.
Please note that informed consent from participants can only be obtained after ethics approval has been granted. It is your responsibility as researcher to keep signed informed consent forms for inspection for the duration of the research.

We wish you the best as you conduct your research.
If you have any questions or need further help, please contact the REC office at 0218089183.

Included Documents:

Letter requesting SU permission
Application form
Letter of support - SciMathUs
DESC Form
Letter of permission - SciMathUs
Research proposal

Sincerely,

Sidney Engelbrecht
REC Coordinator
Research Ethics Committee: Human Research (Humanities)

Investigator Responsibilities

Protection of Human Research Participants

Some of the responsibilities investigators have when conducting research involving human participants are listed below:

1.Conducting the Research. You are responsible for making sure that the research is conducted according to the REC approved research protocol. You are also responsible for the actions of all your co-investigators and research staff involved with this research. You must also ensure that the research is conducted within the standards of your field of research.

2.Participant Enrollment. You may not recruit or enroll participants prior to the REC approval date or after the expiration date of REC approval. All recruitment materials for any form of media must be approved by the REC prior to their use. If you need to recruit more participants than was noted in your REC approval letter, you must submit an amendment requesting an increase in the number of participants.

3.Informed Consent. You are responsible for obtaining and documenting effective informed consent using **only** the REC-approved consent documents, and for ensuring that no human participants are involved in research prior to obtaining their informed consent. Please give all participants copies of the signed informed consent documents. Keep the originals in your secured research files for at least five (5) years.

4.Continuing Review. The REC must review and approve all REC-approved research protocols at intervals appropriate to the degree of risk but not less than once per year. There is **no grace period.** Prior to the date on which the REC approval of the research expires, **it is your responsibility to submit the continuing review report in a timely fashion to ensure a lapse in REC approval does not occur.** If REC approval of your research lapses, you must stop new participant enrollment, and contact the REC office immediately.

5.Amendments and Changes. If you wish to amend or change any aspect of your research (such as research design, interventions or procedures, number of participants, participant population, informed consent document, instruments, surveys or recruiting material), you must submit the amendment to the REC for review using the current Amendment Form. You **may not initiate** any amendments or changes to your research without first obtaining written REC review and approval. The **only exception** is when it is necessary to eliminate apparent immediate hazards to participants and the REC should be immediately informed of this necessity.

6.Adverse or Unanticipated Events. Any serious adverse events, participant complaints, and all unanticipated problems that involve risks to participants or others, as well as any research related injuries, occurring at this institution or at other performance sites must be reported to Malene Fouch within **five (5) days** of discovery of the incident. You must also report any instances of serious or continuing problems, or non-compliance with the RECs requirements for protecting human research participants. The only exception to this policy is that the death of a research participant must be reported in accordance with the Stellenbosch Universtiy Research Ethics Committee Standard Operating Procedures. All reportable events should be submitted to the REC using the Serious Adverse Event Report Form.

7.Research Record Keeping. You must keep the following research related records, at a minimum, in a secure location for a minimum of five years: the REC approved research protocol and all amendments; all informed consent documents; recruiting materials; continuing review reports; adverse or unanticipated events; and all correspondence from the REC

8.Reports to Sponsor. When you submit the required reports to your sponsor, you **must** provide a copy of that report to the REC. You may submit the report at the time of continuing REC review.

9.Provision of Counselling or emergency support. When a dedicated counsellor or phsychologis provides support to a participant without prior REC review and approval, to the extent permitted by law, such activities will not be recognised as research nor the data used in support of research. Such cases should be indicated in the progress report or final report.

10.Final reports. When you have completed (no further participant enrollment, interactions, interventions or data analysis) or stopped work on your research, you must submit a Final Report to the REC.

11.On-Site Evaluations, Inspections, or Audits. If you are notified that your research will be reviewed or audited by the sponsor or any other external agency or any internal group, you must inform the REC immediately of the impending audit/evaluation.