ANALYSIS OF STUDENT SUCCESS IN MECHANICAL ENGINEERING AT THE DURBAN UNIVERSITY OF TECHNOLOGY

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Declaration

I declare that this thesis is my own unaided work except where due acknowledgement is made to others. This thesis is being submitted for the Masters of Engineering degree to the Department of Mechanical Engineering at the Durban University of Technology, and has not been submitted previously for any other degree or examination.

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Abstract

The department of Mechanical Engineering at the Durban University of Technology currently offers a National Diploma (ND) and a Bachelor's Degree in Technology (BTech), as well as a MEng. and a DEng. This thesis details four areas of study that were undertaken in an attempt to identify potential impediments to student success in the department, using readily available data. The universities' management information system (ITS) was the primary source of data, but limited data was also obtained from courses that the author taught, as outlined in section (4) below. A grounded action research framework was selected as the methodological framework for these studies as it allowed the freedom to refine an investigation as it progressed as well as to implement potential solutions and determine their efficacy.

The four areas covered were: (1) Analysis of trends in student success rates. A number of changes were made to the National Diploma over a five year period including the introduction of supplementary examinations, the removal of elective offerings, the change in the sequence of subjects offered and a reduction in contact time. This same period also coincided with the first cohort of students entering with the new NSC matric qualification.

This study examined the success rates within subjects, across four semesters of study, from 2007 until 2010 and attempts to show the effects, either positive or negative, that these changes have had. The success rates of subjects within the BTech programme were also interrogated for this same period. These results were also categorised according to whether students obtained their diploma at DUT or at another institution allowing a comparison between the two cohorts.

(2) Workplace Learning (WPL). Anecdotal evidence suggested that the manner in which the WPL components were offered had a negative effect on student throughput as well as not providing substantial opportunity for the integration of experience gained in industry with the academic programme. This study, utilising WPL registrations from 2007 to 2010, examined the average time taken to complete the WPL components, the percentage of the academic component completed before and during the WPL period as well as the dropout rate.

(3) Relationship between NSC results and success in Mechanical Engineering. The purpose of this study was to determine if relationships could be found between student's NSC results and

success within the programme. This would inform if the departmental entrance requirements were of an appropriate level to ensure prospective students a reasonable chance of success. Results of selected NSC subjects were correlated with those of selected diploma subjects. The distributions of success in these subjects were tabulated against the NSC results allowing a better understanding of the relationship between them.

(4) Investigation into causes of poor performance in Hydraulic Machines III. This study was undertaken to better understand the competencies and learning practices of the students in the author's class. This involved the interrogation of the performance of students over a number of assessments, the tracking of usage of online resources and the tracking of lecture attendance, and subsequent correlation with performance.

These studies have led to a better understanding of the programmes offered and have put the department in a position to make informed decisions regarding interventions aimed at increasing student success. The work covered in this thesis was presented in two full papers (Graham and Walker, 2011, Graham and Walker, 2015) and two extended abstracts (Graham and Walker, 2013, Walker and Graham, 2013).

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List of Subject Name Abbreviations

Applied Strength of Materials (Applied III)
Automatic Control IV (Control IV)
Communication Studies I (Comms I)
Computer Aided Drafting I (CAD I)
Computer Programming Skills (Comp I)
Electrotechnology I (Electros I)
Electrotechnology III (Electros III)
Engineering Design Project IV (Design IV)
Engineering Materials & Science IV (Materials IV)
Engineering Materials And Science I (Materials I)
Fluid Mechanics II (Fluids II)
Fluid Mechanics III (Fluids III)
Fluids Mechanics IV (Fluids IV)
Hydraulic Machines (Hydraulics III)
Machine Design III (Machine Design III)
Manufacturing I (Manufact I)
Manufacturing III (Manufact III)
Mathematics I (Maths I)
Mathematics II (Maths II)
Mathematics III (Maths III)
Mechanical Engineering Design II (Design II)
Mechanical Engineering Drawing I (Drawing I)
Mechanics Engineering Design III (Eng Design III)
Mechanics I (Mechanics I)
Mechanics of Machines IV (Mechanics IV)
Mechanics of Machines II (Mechanics II)
Mechanics of Machines III (Mechanics III)
Percentage point increase (pp)
Refrigeration and Air conditioning IV (Refrig IV)
Steam Plant III (Steam Plant)
Strength of Materials II (Strengths II)
Strength of Materials III (Strengths III)
Strength of Materials IV (Strengths IV)
Stress Analysis IV (Stress IV)
Theory of Machines III (Theory III)
Thermodynamics II (Thermos II)
Thermodynamics III (Thermos III)

Chapter 1

Literature Review

1.1 Introduction

The Global Competitiveness Report 2013-2014 (Schwab, 2013), compiled by the World Economic Forum, assesses the competitiveness landscape of 148 economies, providing insight into the drivers of their productivity and prosperity. The report paints a bleak picture when it discusses the South African education sector. Mathematics and science teaching are seen as the worst in the world, coming last out of 148 countries. The overall quality of its primary and secondary education systems are placed at 133^{rd} and 146^{th} respectively. South Africa places poorly at 102^{nd} for tertiary education enrolment rate and 122^{nd} for primary education enrolment rate. The report identifies the primary, secondary and tertiary education sectors as major impediments to improved economic growth. Numerous studies, a few of which are discussed below, further explore the challenges facing both basic and higher education in South Africa.

1.2 Basic Education

Multiple researchers highlight many deficiencies in, and challenges faced by, the primary and secondary education system. Fleisch (2008) points to primary school benchmark tests, such as the Progress in International Reading Literacy Study (Martin et al., 2007), that show that nearly 80% of South African children do not have basic reading skills by the time they reach grade five, and only 2% measure up to the highest international standards of literacy. He also shows that although a small minority of mainly privileged schoolchildren do achieve at benchmark levels, the vast majority never achieve basic competence in reading, writing and mathematics.

Similarly, Spaull (2013) describes a primary education sector where only 25 percent of schools are functional and the remainder are unable to impart to learners the foundational knowledge and skills they should be acquiring. He describes a system where most children perform significantly below the requirements of the curriculum, often failing to acquire functional numeracy and literacy skills. Learning deficits that are acquired in primary school grow over time to the extent that they become insurmountable and preclude learners from following the curriculum at higher grades, especially in mathematics and science. He concludes that part of this is because South African primary school mathematics teachers have the lowest curriculum knowledge amongst sub-Saharan African peers, and in many instances they cannot even answer problems related to the curriculum they are teaching. This is further acknowledged by Reddy (2006), who determined that when benchmarked internationally South African science and mathematics teachers are amongst the least qualified.

The Initial Teacher Education Research Project (JET Education Services, 2014) compiles the findings of a number of research programmes, both large and small, with very similar findings to those above. The report describes low levels of subject knowledge and proficiency amongst teachers, especially in English, mathematics and sciences, as endemic in schools across the country. This the leads to large numbers of learners reaching grade 5 essentially illiterate and grade 7 innumerate.

South Africa's youth unemployment rate is far higher than both global and sub-Saharan rates (Rankin and Roberts, 2011, Swanson, 2013). A major contributor to this is a basic education system that does not provide matriculants with the necessary education, required by employers, in an economy that increasingly demands highly skilled workers (Nickell and Bell, 1995). Passing the National Senior Certificate (NSC) provides the youth with no significant advantage in finding employment over to those without, however its major advantage is that it may allow entrance to higher education (Spaull, 2013). The poor quality of basic education, as outlined above, limits a youth's ability to gain access to higher education and subsequent entrance to the workforce.

1.3 Higher Education

Higher education in general and engineering education in particular, in South Africa face many challenges. There is a scarcity of students that both qualify for, and choose to enter engineering programmes, and many of those that do have poor educational backgrounds and go on to struggle in the higher education environment (Case, 2006). The under preparedness of school leavers places a burden on higher education institutions as the task of re-teaching fundamental skills, that should have been acquired at school, has now become the task of higher education (Kruss, 2004).

Added to the challenge of increasingly underprepared school leavers, Universities and Universities of Technology are also facing policy changes. The nationwide restructure of qualifications under the new Higher Education Qualifications Sub-Framework (HEQSF, 2013) poses a new set of challenges for educators, especially at Universities of Technology, as they re-curriculate and introduce new qualifications.

The throughput rates for undergraduate engineering courses in South Africa are far below the required benchmark (Fisher, 2011), with students studying towards the National Diploma at Universities of Technology faring the worst (Roodt, 2009). Scott et al. (2007) state that the existing higher education system is no longer effective as the majority of students entering the sector do not complete their studies. They continue by stating that increasing the intake of students into engineering programmes would not be an efficient means of increasing graduation rates, but rather that the success within these programmes should be targeted.

The number of science, engineering and technology graduates entering the job market is not sufficient to meet the demand for these scarce skills (Cosser, 2010, Taylor, 2008). This shortage of skills is identified as a critical impediment to economic growth with the per capita number of qualified engineering professionals being below that expected for a country at South Africa's level of development (Roodt, 2009, National Planning Commission, 2013).

For these reasons, university departments should be investigating and implementing methods to increase student success within their programmess. Factors affecting student success can be internal to students, such as self-confidence, attitude and abilities (Felder et al., 1998), as well as external to students, such as pedagogy, quality of instruction and programme design (Muraskin and Lee, 2004, Wang et al., 1997). The first efforts to improve student success should focus on factors external to students such as the curriculum and how it is offered (Zinatelli and Dubé, 1999), as opposed to internal factors such as motivation and attitude, which are by and large outside departmental control. External factors such as curriculum changes, appointment of educational specialists, maintaining the quality of incoming students, improving the learning climate, developing staff teaching skills and ensuring effective student support are suggested (Fraser, 2008). Curriculum changes, specific to engineering courses, such as renewing curriculum to effectively integrate literacy and numeracy (Owen, 2008) and to increase the level of engineering application in entry level courses (Klingbeil, 2004) have also proven successful. Although focus should first take place on external factors, an understanding of internal factors can help shape curriculum and pedagogy in order to create conditions more conducive to the success of students (Bernold et al., 2007).

Dealing with structural issues in the curriculum, such as a ‘bottleneck’ subject with poor performance, can lead to improved overall student success, but locating the bottleneck can often be a major task (Roser et al., 2002). An example of a successful intervention of this type is described by Ohland et al. (2004) in their paper "Identifying and removing a calculus prerequisite as a bottleneck in Clemson's General Engineering Curriculum". They successfully used a longitudinal analysis of student records to determine that a subject offered in first semester subject (Calculus I) of an Engineering course, acted as a major bottleneck to progression through the programme. This was because the subject was a pre-requisite for the majority of the second semester subjects in the programme. The subject was changed to a co-requisite for these subjects thus allowing students who failed it on their first attempt to repeat it in the second semester alongside subjects that would have been previously unavailable to them. Longitudinal studies then showed a significant improvement in the retention of students in the programme, with the conclusion that the adjusted curriculum helped a large number of students.

As mentioned earlier, the development of staff teaching skills is another external factor that should be addressed. Many engineering educators still teach in the same manner in which they were taught, but these pedagogies may no longer be relevant for current students (Felder, 2012). This is especially true in the South African context where, as mentioned earlier, the school system has left the majority of school leavers unprepared for the challenges they face in higher education.

Educators need to understand students and their weaknesses before dramatically adapting teaching practices (Felder et al., 1998). As they become comfortable with new teaching methods, and learn more about their students’ strengths and weaknesses they should start to see improvements in their students’ performances. In order to do this, educators should find out which students are performing poorly and question why this is. Determining whether poor performance is general, limited to certain students or limited to certain sections of the curriculum allows educators to change their teaching to address these issues. (Zimmerman and Pons, 1986). Analysis of students’ assessments as well as student feedback gained from surveys, minute papers, spot tests or focus groups can all be used to help determine the causes of poor performance. Kember (2002) however, warns that feedback gathered from generic student surveys, as utilised by many universities, generally does not lead to an improvement in teaching practice. In cases where it does, it is because educators have utilised this feedback together with their own methods of evaluating their teaching (Kember, 2000).

It is important to attract, engage and retain students that have a reasonable chance of success into programmes, and maintenance of these admission requirements is another one of the factors under departmental control. Enrolling students with little chance of success is generally regarded as unethical (Browne-Miller, 1996), as well as being financially detrimental, due to reduced throughput and graduation rates (Rankin et al., 2012, Imran et al., 2014). Zaaiman et al. (2000) argue that selection into a programme is a contract to teach at that level and that the either entrance requirements must be adjusted to the teaching level, or the teaching level must be adjusted to the entrance requirements.

Most South African Universities utilise the NSC examination results in their admission processes. These examinations are quality controlled by Umalusi, the council for quality assurance. Due to the standardised nature of these examinations they should be seen as a reliable measure of academic potential and allow for the ranking of applicants accordingly. Numerous studies show that success in first year university courses correlate highly with matriculation results (Tewari, 2014, Van Eeden et al., 2001, Jawitz, 1995). The NSC is however relatively new, having replaced the Senior Certificate in 2008, and there is still uncertainty as to its reliability as a predictor of academic success (Schoer et al., 2010). The credibility of the NSC mathematics marks in particular have been brought into question (Rankin et al., 2012, Du Plessis and Gerber, 2012, Dennis and Murray, 2012), although this may have already been an issue in Senior Certificate (SC) mathematics prior to the introduction of the NSC (Wolmarans et al., 2010). Most institutions did not foresee the mismatch between the abilities of the NSC students and institutional admission requirements and as a result numerous students, who stood little chance of success were admitted into programmes (Potgieter and Davidowitz, 2010). Nel (2009) suggest that further longitudinal investigation should be undertaken to determine the full impact of the NSC on access and admission to higher education.

1.4 Research in Higher Education

Educational research often covers many disciplines, including psychology, sociology, anthropology, science, and philosophy (Yates, 2004) and refers to a variety of paradigms, frameworks and methods to evaluate diverse aspects of education. What all frameworks hold in common is that research must be conducted in a rigorous and systematic way (Anderson and Arsenault, 1998). Research in education most often follows a quantitative, a qualitative or a mixed methodology, each of which is associated, although not exclusively, with a particular paradigm. A brief review of these methods and associated paradigms is outlined below.

Quantitative research methods are defined by the collection and analysis of numerical data, utilising mathematical based methods, often statistics, to explain a particular phenomenon (Aliaga and Gunderson, 2000). Certain questions lend themselves to be answered using quantitative methods, as the data to be utilised is already in numerical form. What percentage of engineering students are female? How many students complete a qualification in the minimum time? Have pass rates in a subject improved over time? These are examples of questions that are readily answered using quantitative methods. Common quantitative research designs are experimental, longitudinal studies, cross–sectional studies, and case studies. Data collected for these may be obtained from experiments, questionnaires, interviews, observations, surveys, document analysis and secondary data analysis (Muijs, 2010).

Qualitative research methods, although used in many disciplines, are most closely associated with the social sciences. It is an umbrella term that encompasses a wide range of methods which generally do not utilise statistical procedures or quantification, and in which the data is usually descriptive in nature. Some data may be quantified statistically, but if the bulk of the analysis thereof is considered to be interpretative this may still be referred to as qualitative research (Strauss and Corbin, 1990). Case studies, ethnography, action research, phenomenography, discourse analysis and narrative analysis are a few qualitative research method that are increasingly being used in engineering education research (Case and Light, 2011).

The difference between quantitative and qualitative research used to be seen as quite fundamental, with two opposing camps or paradigms involved in what was called the 'paradigm wars' (Gage, 1989). Bryman (2008, p. 13) states that the paradigm wars "centre on the contrasting epistemological and ontological positions that characterize quantitative and qualitative research and their various synonyms". Simply put, quantitative research is typically associated with a positivist/postpositivist, realist or objectivist paradigm, whilst qualitative research often follows a subjectivist, constructivist or interpretevist paradigm (Mackenzie and Knipe, 2006).

Positivism is a philosophical framework that recognises an objective reality which can be scientifically, logically or mathematically proved. Conversely, subjectivism holds that all knowledge is subjective and that there is no external or objective truth. These definitions however hold the extremes of a spectrum, so if they are taken at face value, as when used by critics of one method to attack users of different methods, they appear to make quantitative and qualitative research methods incompatible, whilst that is not necessarily the case (Muijs, 2010). Postpositivists, like positivists, believe that a reality exists, but they differ in that they acknowledge that their own subjectivity plays a part in shaping this reality. To the postpositivist reality is something that is approximate as opposed to absolute of the positivist.

Pragmatism, or the pragmatic paradigm, is a framework that considers that most philosophical topics such as epistemology, language, belief and science should be viewed in terms of their usefulness. The pragmatic paradigm views the research problem as the principal part of any research project and holds no philosophical loyalty to any particular framework (Creswell, Plano Clark, Gutmann, and Hanson, 2003). As such, any methods chosen to collect or analyse data are done on the basis of how best they can be utilised to answer the research question. The pragmatic paradigm can be applied to any research methodology but is primarily viewed as providing the best philosophical framework for mixed-methods research (Somekh and Lewin, 2005; Teddlie and Tashakkori, 2003).

The goal of mixed method research is not to replace quantitative nor qualitative approaches, but rather to draw from the strengths of both in a single research study where appropriate (Johnson and Onwuegbuzie, 2004, Teddlie and Tashakkori, 2003). This allows for a research methodology that is closer to what researchers use in practice (Johnson and Onwuegbuzie, 2004). If research can be described as a continuum with qualitative research at one end and quantitative research at the other then mixed methods research would cover all the space between. Due to the complex nature of education research a practical or pragmatic approach is to use different methods depending on the phenomenon being investigated. For example a quantitative approach, using focus groups or interviews, could be used to explore the challenges faced by female students in a male dominated programme. A quantitative approach could be used to determine if there is a differential in success rates between female and male students enrolled in an engineering programme. A mixed methods approach could combine the two scenarios above, using quantitative methods to determine if there is a differential in success rates and qualitative methods to explain the reasons if this is the case. No single methodology is viewed as superior, the choice of the methodology is based solely on which is most appropriate (Borrego et al., 2009).

It is important that researcher should identify a personal philosophical position, or paradigm, before conceptualising a research study in order to better make decisions with regard the methodology employed.(Birks and Mills, 2011). Further, declaring this philosophical position helps communicate assumptions made, the methods chosen, and how the results are interpreted (Jawitz and Case, 2009).

The author of this thesis positions himself in the pragmatic paradigm and although mostly quantitative methods were used, qualitative methods were used where necessary in this study. The framework under which the research was carried out follows that of grounded theory, although aspects of grounded action research were utilised.

Grounded theory derives its theoretical underpinnings from pragmatism (Corbin and Strauss, 1990), and a grounded theory is one that "is inductively derived from the study of the phenomenon it represents" (Corbin and Strauss, 2007). Action research is evaluative and reflective with the aims of improving practice (Burns, 1999). Grounded action research is combination of the two as it provides a means of implementing actions developed from the grounded theory. It is a process of continual discovery, learning, rediscovery, and relearning (Simmons and Gregory, 2003). Its purpose is to develop an operation theory from the grounded theory and hence to create and apply practical solutions to social problems. This framework allows the freedom to refine an investigation as it progresses as well as to implement potential solutions and determine their efficacy.

Chapter 2

Method

2.1 Department Overview

The department of Mechanical Engineering at the Durban University of Technology currently offers a National Diploma (ND) and a Bachelor's Degree in Technology (BTech), as well as a Masters and Doctoral degree. There are two options within the diploma: a mainstream option and a mechatronics option. The mainstream offering comprises of traditional mechanical engineering subjects whilst the mechatronics offering comprises of a mix of mechanical, electrical and electronic engineering subjects. The diploma consists of four semesters of academic tuition and two semesters of Work Place Learning (WPL). The four academic semesters are known as S1, S2, S3 and S4 respectively, whilst the two semesters of WPL are known as P1 and P2 respectively. Students that have completed the ND may opt to pursue a BTech, which is offered on a full or part-time basis. The ND has two intakes per annum, with new students registering in both January and July, meaning all ND course need to be offered every semester. The BTech also has two intakes per annum but because the subject material is not hierarchical individual subjects are only offered once per year.

2.2 Analysis of trends in student success rates

Very little, if any, analysis had been done to determine the impact of changes made to the Mechanical Engineering programme. The wealth of information available on the University ITS and MIS systems can be analysed to determine the effects these interventions and changes had made to student success and/or throughput rates. Although increased graduation and throughput rates are the long term goal of the department, increasing the success rates in individual subjects is the logical first step to addressing increasing overall success in the programme.

Success rate is defined as the percentage of students that achieved a passing grade (including supplementary examinations) divided by the total number of students registered for the subject at the time of examination. A pass rate is the percentage of students passing a subject divided by the number writing the examination. Instances may occur where a subject may have a good pass rate but a poor success rate. These occur if large numbers of students have not achieved the coursemark subminimum (DP) required for exam entrance. For this reason the success rates were chosen here over pass rates as the measure of student success within individual subjects.

A longitudinal study, measuring the success rates of all subjects offered in both the diploma and BTech, was undertaken. This covered period of eight semesters starting with the first semester of 2007 and ending with the second semester of 2010. An analysis of the success rates prior and post changes to the programme would shed light on their effects. Factors contributing to student success however are vast and complex making it impossible to examine every potential factor. Conclusions thus cannot be definitive and are stated in terms of likelihood rather than certainty.

Raw data was obtained from class lists generated by the ITS system. Students that deregistered from a subject, as well as those registered on a non-diploma basis were excluded. With the exception of the above, all data analysed was from the full data set. The data utilised was nominal in the sense that final results of either pass or fail were retrieved rather than the final percentage mark.

The results retrieved by ITS class lists are determined by the examination code assigned to a particular exam period. For example a class list generated using the year end main exam code would give the results of the entire class at that time. It would not include the results of the supplementary exams, even if they had already been written. Thus results for a number of students would still reflect as a fail even though they had already passed the supplementary exam. Similarly when a class list is generated using the supplementary exam code the list shows the results of only students that qualified for the supplementary, not the whole class.

To determine the overall success rate information was retrieved from both the main exam and the supplementary exam lists. This led to an interesting side study, described later in the chapter, with regards the effectiveness of the supplementary exams as success rates for both the main exam and the supplementary exam had been already been calculated in order to determine overall success rates.

The success rates determined above were analysed to provide insight into a number of areas, viz.:

2.2.1 The Impact of the New NSC

There was concern that the level of mathematics and physic at grade 12, offered in the new NSC, would prove to be inadequate for the technical courses of the mechanical engineering programme. A geometry module was added to the programme in S1 to help address the lack of geometry in the NSC qualification. This course would be compulsory for all students who had not completed the geometry module at school. The department equated the NSC grade level 4 with the senior certificate Higher Grade E and the Standard Grade C, and used these as the minimum Mathematics and Science entrance requirements.

In order to test that these levels were similar, the success rates for both S1 and S2 were compared prior to and post the introduction of the NSC qualifications. The majority of new students entering S1 in the first semester 2009 would hold the NSC qualification, however repeating students would hold the old senior certificate. Students that do not complete S1 within two semesters are excluded from the programme, so by the second semester 2009 NSC students would comprise the majority of the S1 class. The first NSC students would enter S2 in the second semester 2009 and comprise the majority by the beginning of 2010.

2.2.2 The Impact of a Reduction in Contact Time

The reduction of contact time, as a consequence of the decision to move from a 45 minute to a one hour period at the beginning of the first semester of 2009, was also investigated. The change to one hour periods saw an approximate 20 percent reduction in contact time per subject. There was much debate at the time as to whether the department was ‘over-teaching’ or not, with many lecturers predicting dire consequences if contact time were to be reduced.

Average success rates for the four semesters preceding the introduction and the four semesters afterwards were examined at all S levels. If there was an effect it was assumed that there would be a steep drop coinciding with the reduction in contact time, followed by improvement as the students and staff adjusted the new regime. This coincided with the introduction of the NSC students to the S1 programme so the analysis would concentrate on the S2, S3 and S4 cohorts.

2.2.3 The Impact of the Removal of Electives at S4

The department found that a large number of the students were entering the BTech programme without having all the necessary prerequisite subjects (the entrance requirement is simply a National Diploma in mechanical engineering). This had a negative impact on the throughput rate of the BTech programme as many students needed to register for diploma level prerequisite subjects in tandem with BTech subjects (that students had the prerequisites for). This also provided a major obstacle for students wishing to register for the BTech on a part time basis as they could not attend the daytime offering of these prerequisite subjects. It was decided that the diploma programme should be rearranged such that all students graduating with the diploma would have completed all the necessary prerequisites for the BTech programme. This required the removal of certain electives as well as making other subjects compulsory in the diploma programme.

Mechanical Manufacturing Engineering II and Electrotechnology II were removed from the S2 curriculum, Mechanical Manufacturing Engineering III from the S3 curriculum and Manufacturing Management III and Electrotechnology III from the S4 curriculum, all effective from the first semester 2009.

By removing these electives, some of which were perceived as ‘soft’ options, and increasing the number of compulsory ‘difficult’ subjects, the department believed that there may be a negative effect on the success rates in these now compulsory subjects. It was felt that any decrease in success rates within diploma programme would be outweighed by positive changes to BTech throughput rates.

The elective course class sizes were generally quite small - on average a third of that of the compulsory subjects, so the impact of removing them was not be expected to be of major significance to the average success rates at the lower levels.

Previously, students could complete the diploma with only two majors at the S4 level. With the electives removed they would now have to complete five major subjects viz. Theory of Machines III, Machine Design III, Applied Strength of Materials III, Mathematics III and either Hydraulic Machines III or Steam Plant III. The rule making these subjects compulsory only applied to students first entering the diploma in 2009, but the removal of the electives would leave fewer options available to current S4 students, such that students would need to complete the majority of these anyway.

Students that found difficulty with a particular stream, Strength of Materials for example, could have avoided the S4 version (called Applied Strengths III) by using credits gained earlier, or at the S4 level, from electives. As this was no longer possible the department expected a decrease in success rates in some of these subjects newly made compulsory. An analysis of the individual S4 subject success rates gave an idea as to the effect of the removal of these electives.

2.2.4 Performance of Students in the BTech Programme

Anecdotal evidence suggested that BTech students who had not obtained their diploma at DUT struggled with a number of BTech subjects. To test this success rates in each subject were differentiated according to whether students obtained their diploma at DUT or another institution to allow comparison of these two cohorts.

2.2.5 Effectiveness of Supplementary Examinations

Prior to the implementation of supplementary examinations in 2006, students obtaining a final mark of between 45 and 49%, and those who achieved a course mark of above 60%, regardless of their examination result, could rewrite the examination during the following examination session. This caused a delay of one full semester and saw no real benefit for the student, other than saving the subject registration.

Supplementary examinations are now written directly after the release of examination results, with results being released before the next registration period. Thus if a student passes the supplementary exam they would be able to proceed with the programme without a semester delay. To determine the effect of supplementary exams the success rates for all subjects, prior to and subsequent to the supplementary session, were collated. The difference between these two values shows the percentage point increase in success rates attributable to the supplementary examination in each subject. Continually assessed courses would have a percentage point increase of zero points (because there are no exams/supps for continually assessed courses). These rates, including the continually assessed courses, were weighted, according to the number of students registered to determine the magnitude of the effect at each level.

2.2.6 The impact of moving Electrotechnology I from S1 to S3

For a number of semesters the success rates of Electrotechnology I were far below those of other subjects at the same level. As the subject was serviced by another department there were few interventions that the Mechanical Engineering Department could effect in order to increase success rates. It was felt that if the subject was offered later in the diploma then students may be more mature and possess better learning and/or study skills and so perform better. It was decided, as of the first semester 2009, to move the mainstream subject offering from the first semester (S1) to the third semester (S3) level of study.

Students registered for the Mechatronics option within the diploma would not be able to take this subject in their third semester as it is a prerequisite for multiple S2 and S3 mechatronics subjects. Electrotechnology I would continue to be offered at S1 for these students. The timetable was arranged so that the mainstream and mechatronics students attend the same classes together.

Average success rates for the four semesters preceding this change and the four semesters afterwards were determined for both groups of students and analysed.

2.3 Workplace Learning (WPL)

The diploma includes two formal workplace learning periods, each six months in duration, called P1 and P2 respectively. It was originally intended that these would be 'sandwiched' between the academic semesters to ensure maximum integration between the academic and experiential components. This is in line with the South Africa Society for Cooperative Education (Forbes, 2007) description of WIL, of which WPL is a subset, as a structured part of a qualification that integrates work experience with classroom study. Further, WIL should not be viewed as an add-on to the curriculum (Lessing et al., 2001), but rather should be integrated with teaching and learning within the classroom.

WPL registration is dealt with by the MIS in the same manner as the academic subjects. It opens for registration at the beginning of a semester and results are released at the end of the semester. Students are required to complete a set of core learning elements that are assessed by their workplace mentor. These are recorded in a logbook and submitted to the department along with a report upon completion of P1 and P2. The logbooks are then evaluated by the department and the status of the ‘subject’ (i.e. P1 or P2) changed to a pass if all is in order. If information is missing or the student is found to be not competent for any of the learning elements he would be given the opportunity to resubmit the logbook. If a logbook has not been submitted and approved by the end of the semester the status of the student registered would automatically be changed a fail. The student would be required to reregister for the subject before the logbook could be submitted.

Due to the perceived difficulty in finding WPL placements the department has for many years allowed students to undertake the WPL components at any time within their course of studies instead of the more desirable ‘sandwich’ model. It has been suspected that this practice led to the majority of students registering for WPL upon, or near to the completion of, the academic portion of the programme reducing the effectiveness of WPL by relegating it to an add-on.

Anecdotal evidence also suggested that a large portion of students spent significantly more time than necessary to complete WPL, negatively impacting throughput rates. This was assumed to be due to the difficulty in finding placements, as well as late WPL registration and log book submission. Furthermore it was also believed that a significant percentage of students dropped out during the WPL period. After securing WPL placement, and hence gainful employment it was thought that a number of students chose to remain in employment and not return to the university. These students would not complete their WPL and more significantly never graduate. In order for the department to better understand the impact of WPL on the programme it was decided to investigate these issues. The investigation was fairly open with the results obtained from the first part of the investigation informing the following phase.

The first work done was a longitudinal study, measuring the pass rates of first time and repeat students registered for P1 and P2. This covered period of eight semesters starting with the first semester of 2007 and ending with the second semester of 2010. This was intended to determine the average time, or number of semesters taken to complete WPL. Further, if for example, the pass rate for first time registered P1 and P2 students was over 90% it would have precluded the need for further investigation into issues relating to time taken to complete WPL and retention.

Upon commencement of this study it was determined that the data on hand would not be sufficient to fully answer the questions posed. It was found that students shown as registering and passing P1 in their first registration may have actually taken more than six months to complete it. Conversely students shown to have failed their first P1 registration and then passed it the following semester could well have taken only six months to complete. The reason for this is the manner in which WPL is registered by the University. WPL registration is dealt with in the same fashion as a regular academic subject. As mentioned previously WPL registration opens at the beginning of a semester and results are released at the end of the semester. Students however do not all start WPL at the beginning of the semester.

For example a student that registers for P1 in the middle of the first semester and takes the required six months to complete would be recorded as a P1 failure at the end of the first semester and a P1 pass at the end of the second semester. Thus using the pass rate statistics generated from the ITS system could lead to the conclusion that the student in question took 12 months (2 semesters) to complete P1 when the student in fact took 6 months to complete. Similarly a student that 'starts' P1 in the middle of the first semester, registers for it at the beginning of the second semester and hands in his log book at the end of the second semester would be seen to have passed P1 within the minimum six months, whereas he/she actually took longer.

A further shortcoming was that this longitudinal study would only indicate whether a student was registered for the first time or repeating. It could not determine if a student had been registered for WPL more than twice. Despite these shortcomings it was decided to continue with this study to see what useful other information could be found to inform the direction of further investigation.

One such use for this information was to determine the number of students who dropped out during WPL. For example, if over an extended time period there were no dropouts (or exclusions) the number of students who register for P1 should equal the number that register for P2, i.e. all those that complete P1 should go on to complete P2. It is feasible that some students return to the university between P1 and P2 and are then excluded academically due to poor performance but further research showed that this was unlikely. Due to the significant variation in first time registrations per semester, and the large number of repeating students, it was difficult to obtain the percentage of students that drop out over any particular semester. It was much more instructive to take the total first time registrations and total passes over the entire seven semester period to calculate the average dropout rate. Here the information from the longitudinal study was tabulated in terms of absolute numbers registered each semester instead of as success rates.

To determine the average time to complete WPL it was required to look at the problem in a different way. The academic records of all students that graduated in April 2009, September 2009, April 2010, September 2010 and April 2011 were generated and information was manually entered onto spreadsheets. It must therefore be borne in mind then that this average time taken would only represent students who graduated. Students who drop out after registering for P1 would not be included.

To determine the average time to complete the WPL, the number of semesters each student spent registered for, or attempting to find placement for WPL was counted and collated. Students who registered for WPL components and completed it more than a semester later, without returning to the academic programme, were assumed to have remained in the workplace, and this time was included in the calculation. Similarly if a student finished a period of study and then six months later registered for WPL it was assumed that the student had either spent the full six months looking for a company to offer them WPL, or spent part or all of it, engaged in WPL but not registered with the institution. If there was an unaccounted for period between two academic registrations with no WPL registration it was assumed that the student was not engaged in WPL. It was assumed in cases like this that the student ‘stopped out’ for financial, health or other personal reasons. Thus the average time to complete WPL calculated refers to the total time spent in the workplace or spent looking for WPL, not just the period registered with the University. Further to this the percentage of students completing WPL in the minimum time was also calculated.

The number of students completing the entire academic programme before starting WPL, as well as the average number of subjects completed by students after registering for WPL were counted and tabulated. It should be noted that when referring to the average number of subjects completed by students registering for WPL the average is calculated by dividing the number of individual subjects registrations by the number of students who registered for academic subjects during this period, not the total number of students in this study.

2.3 Relationship between NSC results and success in mechanical engineering

Departmental entrance requirements, which are based on NSC results, should ensure that students admitted into the programme have a reasonable chance of success. To do otherwise would be both unfair to the students and detrimental to the department in terms of throughput. To gain entrance to the Diploma a prospective student must, as a minimum, have achieved a level 4 (50%) for NSC Maths, Physics and English. A points system is also in place where the point score is the sum of the NSC achievement level for all subjects with NSC Maths and Physics scoring double. The minimum score required is 28.

It follows that if students that meet, but do not substantially exceed the entrance requirements, have little chance of success, then these requirements should either be raised, or interventions be put into place to support these students.

2.4.1 Pilot Study

In an attempt to better understand the impact of students NSC results on success, a pilot study using all first time students registered for Engineering Materials and Science I (Materials I) in the second semester of 2011, was undertaken. Materials I is compulsory, and at the time was offered during S3. The purpose was to determine if correlation could be found between a student's NSC results for English and results obtained for Engineering Materials and Science I. The correlations would be done separately for both English 1st Language and English 2nd language groups. Materials I was chosen as it assessed predominantly via short essay type questions, as opposed to calculations which tend to dominate the other subjects. The assumption was made that NSC results for English would be a major factor in success in Materials I for second language English speakers due to the essay type questions. If this was to be the case then the effect of NSC English on other subjects would also be investigated.

The academic record of every student registered for Materials I was manually retrieved and their NSC and Materials I results of collated on spreadsheets. The NSC results were recorded according to the national achievement levels system as shown in Table 2.1.

Table 2.1 NSC Achievement Level

Level	Achievement
Level 7	80 - 100% (Outstanding achievement)
Level 6	70 - 79% (Meritorious achievement)
Level 5	60 - 69% (Substantial achievement)
Level 4	50 - 59% (Moderate achievement)
Level 3	40 - 49% (Adequate achievement)
Level 2	30 - 39% (Elementary achievement)
Level 1	0 - 29% (Not achieved – Fail)

The NSC results recorded were the levels, not the percentages achieved. This allowed for rapid capture of data at the expense of accuracy. It was considered acceptable for a pilot study as the purpose was to lead the direction of the full scale study only. The Materials I results recorded were the students final mark. The results for NSC English and Materials I for first time registered students were then correlated according to Pearson's correlation coefficient. It should be borne in mind that correlation coefficients are dependent on the context (Cohen, 1988) . Those used, as shown in Table 2.2 below, were chosen due to their applicability to research in the social sciences.

Table 2.2 Correlation Coefficients

Correlation	Negative	Positive
None	−0.09 to 0.0	0.0 to 0.09
Weak	−0.3 to −0.1	0.1 to 0.3
Medium	−0.5 to −0.3	0.3 to 0.5
Strong	−1.0 to −0.5	0.5 to 1.0

The results ran counter to expectation and the pilot study was broadened to include the correlation between NSC Mathematics, NSC Physical Science and Materials I in the same manner.

Based on the results obtained the study was once again extended, this time to include Mathematics I and Mechanics I. These subjects were chosen as they historically have poor success rates and are commonly held to be ‘bottleneck’ subjects in the programme. It was assumed that NSC English, Maths and Physics would all show significant correlation with Maths I and Mechanics I. It is important to note that these results were drawn from all students registered for Materials I in the second semester of 2011, not just the first time registered students. The Maths I and Mechanics I results used would be from the particular students first registration for that subject. It is also important to note that Materials I was a S3 subject at the time whilst Maths I and Mechanics I are both S1 subjects. Thus this study would exclude students that had dropped out between S1 and S3 and so would not be accurate, but would suffice to lead the direction of the full study.

2.4.2 Full Study

Due to the results obtained in the pilot study the full scale study would examine the correlations between Maths I, Mechanics I and NSC Maths and NSC Physics. The results of all first time students, from both semesters of 2009 and 2010 as well as the first semester of 2011, for Mechanics I and Mathematics I were utilised. The department’s entrance requirements include a points score where the results for Mathematics and Physics are doubled in the calculation. Because of this it was decided to see if the combination of the subjects’ results showed a stronger correlation that these subjects in isolation.

Correlations were determined for each individual semester and presented in tables along with a weighted average for the five semesters. Due to the varying size of each semester it was decided to use a weighted aggregate in order to prevent the smaller samples skewing the data.

To further explore the effect of NSC results on student performance it was decided to examine the effect of NSC results on success rates in these same subjects. Although there was a correlation between the NSC results and the subject results, it was believed that students may ‘aim to just pass’. Students that performed well at school may well be satisfied with a pass at University even though they are capable of achieving more. If a significant number of students behaved as such, this would in essence weaken the correlation. A further limitation of the correlation study is that it shows that students that perform well in the NSC also perform well in their equivalent S1 subjects. It does not show how NSC results affect a student’s chances of passing the subject. It was decided to examine the distribution of success against the NSC results.

The data used was the same as that used in the main correlation study, with one small exception. Only first time students who were registered for both Maths I and Mechanics I were used here. This excludes the small number (2.4% of the total sample) of students who may have been exempted from one of these subjects due to credits obtained at an FET college or other institution. The results for Mechanics I and a Maths I were grouped in bands according to NSC performance. The success rate of students in each of these bands was then calculated and tabulated accordingly.

2.4.3 Further Study

The full study above was undertaken in 2012. It was not possible to investigate the long term performance of the NSC students at that time due to the recent introduction of the NSC. In 2014 a further study was undertaken to look at the long term performance. It was decided not to use either of the 2009 cohorts as they comprised mainly of non NSC students. The 2010 first semester comprised mainly of NSC students. The academic records of all NCS students were generated and the relevant information tabulated.

Students are allowed a maximum of 5 years in which to complete the diploma. It is not possible to look at graduation as a measure of success for this cohort as only four years have passed. Success could be better defined by the average number of subjects passed and failed per semester as well as the dropout and exclusion rates.

It is shown later in this thesis that most students register for WPL after the completion of the academic programme. For this reason most students should have finished the academic portion of the programme within four years. The percentage of students that had completed all academic subjects within the time frame was also recorded. Those that left the university to undertake WPL in the middle of the programme may still return in 2014 to complete the outstanding subjects meaning that these percentages may still increase. Of those that had completed all academic subjects the average number of semesters taken to do this was also calculated.

2.4 Investigation into causes of poor performance in Hydraulic Machines III

This section will explore three methods that were used, in the course Hydraulic Machines III, lectured by the author, to better understand the competencies and learning practices of the students in the class. This involved the interrogation of the performance of students in a number of assessments over multiple semesters, the tracking of student usage of online resources in the second semester of 2012, and interviews held with a small group, also in the second semester of 2012. The intention was to better understand the students and their weakness so that interventions may be put in place in the future.

The course is a semester in length and is run in both semesters. It covers six sections; reaction turbines, Pelton wheels, fan and fan systems, centrifugal pumps, reciprocating pumps and hydraulic machines. Hydraulic Machines III will be used to denote the course whilst hydraulic machines will be used to denote the section within the course. The course is assessed using four minor tests/tutorials, two major tests, three practical assignments and an examination.

2.5.1 Analysis of assessments

It appeared that students in Hydraulic Machines III could often answer calculation questions fairly easily, yet seemed to have very little understanding of the subject material at hand. The assumption is often made that if a student can successfully complete complex calculations he must understand the subject matter, yet academics have disputed this for a long time (Nurrenbern and Pickering, 1987). It is believed by the author that students are following a 'recipe', using 'pattern recognition' or a 'plug and chug approach' in answering calculation questions, and many have little understanding of the key concepts.

Over the preceding four semesters conceptual and theory questions were added to assessments in order to test the students understanding of the material, its applicability and its context. These questions were also designed to determine if students understood the applicability and the manipulation of the relevant equations.

It was decided to analyse the performance of students in individual questions in test and exam papers to determine whether performance was generally poor, limited to certain sections of the syllabus, or related to certain question types such as the theory and/or conceptual problems. Also included was a perceived difficulty rating. This would range from 1 to 5 and be the lecturer's opinion as to the difficulty of the question. 1 would be a basic question whilst 5 would be challenging. A class average would be determined for each question and this combined with the perceived difficulty rating would give the lecturer a better understanding of students weaknesses. This would be especially apparent if the same sections or types of questions were problematic in multiple assessments over multiple semesters.

The analysis was conducted on the first and second semester examinations of 2012 as well as the second major test of the second semester 2012. The first major test of the second semester 2012 was also analysed, but less data was gathered, so the analysis was only of the performance in calculation questions versus that of theory or conceptual questions excluding the perceived difficulty rating.

2.5.2 Analysis of online usage

The Moodle online platform has been used in the course starting in 2011. Tutorials, quizzes, videos and other resources were posted online with the intention of providing practice in the answering of conceptual type questions. Examples with full solutions were also provided for sections of the syllabus where students had previously performed poorly.

The Moodle platform allows for detailed analysis of usage by students. The system records student logins as well as access to the individual resources, which were exported into spreadsheets so that utilisation by students could be determined. The Moodle website logs visits by individual students to each resource on the site; thus if multiple students watched a video together Moodle would register only the details of the student that logged in. Some of the resources, such as examples and solutions are saved on the site as pdf files, and it should be considered that students may distribute this material to their peers who have not logged on. In an attempt to gain clarity on the above, students were requested, to answer two questions:

Question 1: "When I use the website I access it …"

(a) always by myself
(b) sometimes in a group
(c)) usually in a group
(d) always in a group

Question 2 “when using the examples/solutions posted on the website…”

(a) I have not looked at the examples/solutions online
(b) I have shared this information with classmates electronically
(c) I have shared this information with classmates via hardcopy
(d) I have shared this information with classmates electronically and via hardcopy
(e) I have not shared this information with other students

The results of these questions were used in conjunction with the Moodle login logs. Students that did not use Moodle were asked to state this and refrain from answering the above questions.

2.5.3 Student Interviews

At the end of the second semester of 2012, students who did not achieve a DP were invited to be interviewed. 15 students did not meet the DP requirements for either the practical, academic or both components of the course. 10 of these students accepted the invitation and were interviewed. This was an informal interview held with the students on an individual basis. This group cannot be seen as representative of the class but it does well to represent the weaker students. The number interviewed was small so substantive conclusions could not be drawn but would allow for the author to gain at least a partial understanding as to causes of poor performance. Although this was an informal interview the same base questions were asked of all students. These covered the students preferred methods of study, preparation for various sections, usage on online resources as well as the answering of exam/test papers with regards to calculation and theoretical questions.

Students were made aware that the purpose of the interview was to improve the course for the following semester and that the interview would not affect their DP. It must be borne in mind that students may have believed that these interviews could somehow have affected their DP and this may have affected their answers.

Chapter 3

Results and Discussion

3.1 Analysis of trends in student success rates.

3.1.1 The Impact of the New NSC

3.1.1a. S1 results

The term percentage point (pp) increase is used in this chapter to refer to the arithmetic difference between two percentages, not their ratio. For example if the success rate were to increase from 60% to 75% the percentage point increase would be 15%, but the percentage increase would be 25%.

Table 3.1 S1 subject success rates

	'07 sem 1	'07 sem 2	'08 sem 1	'08 sem 2	'09 sem 1	'09 sem 2	'10 sem 1	'10 sem 2
Maths I	61%	42%	61%	50%	66%	74%	67%	47%
Manufact I	83%	89%	81%	90%	79%	86%	89%	89%
Drawing I	79%	80%	88%	84%	84%	82%	86%	88%
Comms I	94%	94%	93%	84%	87%	88%	91%	76%
Comp I	92%	76%	91%	92%	91%	95%	96%	96%
Mechanics I	74%	55%	59%	51%	57%	57%	62%	57%
Electros I	35%	25%	18%	23%	-	-	-	-

Most S1 subjects show no clear trends across the full period. There is a minor increase across a number of subjects but not such that they were considered significant. Maths I, Electros I and Mechanics I are generally regarded as being more challenging than the other S1 subjects due to their content. It is of no surprise that their success rates are lower than that of the other so-called 'soft options'. The extremely poor results seen for Electros I led to its being moved from S1 to S3, which is discussed later in this chapter.

Mechanics I has a 19 pp difference between the first semester of 2007 and the second semester of 2007. Thereafter the success rates show no major change. Maths I had the greatest variation of success rates with a 32 pp difference between the semester with the largest and that with the smallest. Maths I is also the only subject that shows a significant increase (16 pp) in success rates between the second semester 2008 and the first semester 2009. There is another increase of 8 pp in the second semester of 2009. These rates then drop by 7 and 20 pp in the following two semesters. Maths I is serviced by the Mathematics Department and it is their practice to rotate lecturers between the departments they service each semester. This is most probably responsible for the volatility in the Maths I success rates as there is no similar volatility occurring at the same time in the other subjects. Manufact I had a decreases of 11 pp coinciding in the first semester 2009, thereafter the rates return to the long term mean.

There is nothing about the individual success rates that suggest a change was brought upon by the introduction of students with the NSC qualification.

Table 3.2 Average S1 success rates

	'07 sem 1	'07 sem 2	'08 sem 1	'08 sem 2	'09 sem 1	'09 sem 2	'10 sem 1	'10 sem 2
Overall	74%	64%	66%	58%	76%	78%	81%	73%
Ex. Electros I	80%	71%	77%	70%	76%	78%	81%	73%

The average success rates for S1 students (see Table 3.2) show a 23 pp difference between the semester with the greatest success rate and that with the smallest. There is also a decreasing trend culminating in the second semester of 2008 thereafter a dramatic improvement of 18pp. The final four semesters show neither an increasing nor decreasing trend. The first semester 2009 coincides with both the first intake of NSC students, the removal of Electros I from the S1 curriculum and the reduction in contact time.

If the results for Electros I are removed from the calculation there is an 11 pp difference between the semester with the greatest success rate and the semester with the smallest success rate. The decreasing trend over the first four semesters is greatly reduced and there is only a 6 pp increase between the second semester 2008 and the first semester 2009. This again implies that the introduction of NSC students has had little or no effect on the success rates at the S1 level.

Nonetheless, it should also be borne in mind that the overall workload of the S1 students was decreased by the removal of Electrotechnology 1, and that contact time was reduced at this time as well. The investigation into the reduction in contact time, later in this thesis, shows that the reduction thereof had no measurable effect. It is however possible that the NSC students may be slightly weaker than the Senior Certificate students, and this is being masked by their decreased workload.

3.1.1b. S2 results

Table 3.3 S2 subject success rates

	'07 sem 1	'07 sem 2	'08 sem 1	'08 sem 2	'09 sem 1	'09 sem 2	'10 sem 1	'10 sem 2	mean
Strengths II	58%	66%	59%	65%	59%	47%	48%	64%	58%
Fluids II	74%	74%	67%	47%	63%	51%	43%	54%	59%
Design II	53%	48%	59%	30%	31%	36%	43%	62%	45%
Mechanics II	63%	74%	70%	59%	55%	47%	48%	58%	59%
Materials I	64%	75%	55%	54%	46%	23%	67%	54%	55%
Maths II	55%	52%	49%	54%	58%	62%	70%	50%	56%
Thermos II	63%	74%	67%	56%	76%	58%	58%	56%	64%

Table 3.3 shows the first NSC students started S2 classes in the second semester of 2009 with them constituting the bulk of the class by the first semester 2010. The subject success rates for the second semester of 2009 are generally worse than those of the preceding semester. The number of NSC students in S2 in this semester is unknown, but they are assumed to be the minority. Maths I and Mechanics I both have poor success rates and together are prerequisites for all S2 subjects. This would have been prevented many NSC students from progressing.

Two subjects, namely Maths II and Design II show small increases, whilst the rest decrease. Most notable is Materials I's decrease of 23 pp. This particular result is assumed to be attributable to a new lecturer taking over the course. The results improve dramatically the following semester before decreasing again .What is apparent is that a decline appears to take place for most subjects starting around the first semester 2008.

Table 3.4 Average S2 success rates

	'07 sem 1	'07 sem 2	'08 sem 1	'08 sem 2	'09 sem 1	'09 sem 2	'10 sem 1	'10 sem 2
Overall	61%	66%	61%	52%	55%	46%	54%	57%
Ex. Materials	63%	65%	62%	52%	56%	50%	51%	58%

This decline is also apparent when looking at the average S2 success rates shown in Table 3.4. This table also shows the average success rates if Materials I is removed. This was done to take into account the volatility of the Materials marks assumed to be due the change in lecturer. Both rates show a decrease from the first semester 2008 onwards, indicating the introduction of the NSC had little or no effect on the S2 success rates; rather that there was a trend in place before this. S3 and S4 were not analysed because it was assumed that NSC students would not make up the majority of the class by this time.

3.1.2 The Impact of a Reduction in Contact Time

The S1 average success rates in Table 3.2 show an increase coinciding with the reduction in contact time that took place from the first semester of 2009. If the results for Electros I are removed, as discussed earlier, then the success rate remains relatively constant across the whole eight semesters. The reduction in contact time occurred at the same time that NSC students entered the system and Electros I was moved from S1 to S3. This makes it difficult to determine if the reduction in contact time had a significant effect. It is more useful to look at the S2, S3 and S4 results to determine this.

The S2 individual results in Table 3.3 show three out of seven subjects recording a drop in success rates at this time. Strengths II dropped by 6 pp, Materials by 8 pp and Mechanics II by 4 pp. Fluids III increased by 16 pp, Design II by 5 pp, Maths II by 4 pp and Thermos II by 20 pp. This runs counter to the argument advanced that there would be drastic decreases in success. Looking at this one semester in isolation there is a small decrease in some subjects and a major increase in others.

Looking at the average success rates over the full period gives a clearer understanding. As seen in the section above, the average S2 success rates decrease starting in the first semester 2008, before the reduction in contact time took place. The lowest average success rate does not occur in conjunction with the reduction of contact time but in the semester thereafter. This all implies that reduction in contact time had little effect on S2 success rates.

The S3 success rates in Table 3.5 shows 3 subjects' success rates decrease and three subjects' success rates increase immediately after contact time was reduced. Of those that decrease the Eng Design III and Thermos III both decrease from success rates near 100% to rates very close to their mean. Of those that increase Strengths II shows a consistent improvement across the whole period and CAD I returns to a value close to its mean. Again there is no clear indication that the reduction in contact time led to a significant change in success rates.

Table 3.5 S3 subject success rates

	'07 sem 1	'07 sem 2	'08 sem 1	'08 sem 2	'09 sem 1	'09 sem 2	'10 sem 1	'10 sem 2	mean
Thermo III	77%	44%	58%	97%	80%	67%	65%	63%	69%
Strengths III	31%	37%	50%	49%	67%	58%	80%	73%	56%
Mechanics III	76%	87%	82%	84%	85%	85%	86%	84%	84%
Eng Design II	96%	41%	70%	100%	81%	50%	91%	92%	78%
Fluids III	95%	84%	75%	80%	79%	73%	78%	86%	81%
CAD I	93%	96%	97%	84%	96%	100%	100%	98%	96%
Electros I	-	-	-	-	95%	80%	75%	84%	83%

The average S3 success rates in Table 3.6 also show no dramatic change coinciding with the reduction in contact time. It should be noted that the workload of the average S3 student would also have increased due to the introduction of Electros I at the S3 level at this time.

Table 3.6 Average S3 success rates

	'07 sem 1	'07 sem 2	'08 sem 1	'08 sem 2	'09 sem 1	'09 sem 2	'10 sem 1	'10 sem 2
Overall	77%	61%	70%	80%	83%	74%	81%	84%

The S4 subject success rates shown in Table 3.7 have a wide variation across the whole period. Only two subjects, Theory III and Maths III, show reduced success rates coinciding with the reduction in contact time. However these reductions bring both these subjects close to their mean. The increases in the remaining subjects outweigh these decreases and the average success rate, shown in Table 3.8, increases slightly. The table also shows the average success rates excluding the elective subjects Manufact III and Electros II which will be discussed in the following section.

Table 3.7 S4 subject success rates

	'07 sem 1	'07 sem 2	'08 sem 1	'08 sem 2	'09 sem 1	'09 sem 2	'10 sem 1	'10 sem 2	mean
Theory III	45%	56%	59%	92%	84%	67%	60%	48%	64%
Steam plant	91%	44%	56%	63%	72%	70%	91%	68%	69%
Maths III	75%	46%	61%	79%	70%	85%	80%	57%	69%
Hydraulics III	77%	71%	68%	63%	72%	81%	60%	72%	71%
Machine Design III	54%	41%	71%	57%	70%	53%	55%	43%	55%
Applied III	77%	64%	17%	63%	72%	54%	29%	45%	53%
Manufact III	90%	82%	100%	75%	-	-	-	-	87%
Electros III	100%	71%	93%	80%	-	-	-	-	86%

The first semester 2009 average S4 success rate, shown in Table 3.8, is one of the highest. This occurs immediately after the reduction in contact time again showing the reduction did not lead to a decrease. The success rates decrease the following semesters which may be explained by the removal of elective subjects, Manufact III and Electros III, as discussed in the following section.

Table 3.8 Average S4 success rates

	'07 sem 1	'07 sem 2	'08 sem 1	'08 sem 2	'09 sem 1	'09 sem 2	'10 sem 1	'10 sem 2
Overall	73%	58%	58%	68%	73%	67%	61%	54%
Ex. Manufact III & Electros III	76%	56%	55%	67%	73%	67%	61%	54%

The effect of the reduction on the S1 and S4 results is difficult to quantify, but as the effect on the S2 and S3 results has been negligible, it is likely that the effect on the S1 and S4 course success rates would in all likelihood be negligible too.

3.1.3 The Impact of the Removal of Electives at S4

Table 3.7 shows the two discontinued subjects, Electrotechnology III and Manufacturing Management III, having success rates significantly higher than that of the other S4 subjects. When they are excluded from the average success rates, shown in Table 3.8, the success rate decreases slightly, by between 1 pp and 3 pp. The number of students registered for these subjects was substantially less than those in the remaining ones, which explains why their high success rates do not contribute greatly to the average success rates.

The average success rates trend downwards starting from the first semester of 2009 and reach a low in the second semester of 2010. This low is only 4 pp lower than the success rates of the second semester of 2007 and the first semester of 2008.

The impact of the removal of electives becomes more apparent when looking at the subject success rates shown in Table 3.7. In addition to the removal of Manufact III and Electros III, Theory III, Applied III, Machine Design III and Maths III all became compulsory and students also had to complete either Hydros III or Steam plant III.

Theory III trends downwards, starting from the first semester 2009, with Applied III and Machine Design III both trending downwards, starting from the second semester of 2009. It is worth noting that none of these subjects fell below their previous low. Also, although the success rate for Machine Design III decreased quite dramatically, the number of students passing the subject doubled. This will mean many more students would be able to register for the BTech programme later.

3.1.4 Performance of Students in the BTech Programme

Of the students registered for the BTech a significant number obtain their diploma from other institutions. The term 'non DUT student' will be used, in this section, to refer to these students. The term 'DUT student' will be used to refer to students that received their diploma from DUT.

Table 3.9 BTech success rates 2007

	DUT	n	non DUT	n	Total	n
Refrig IV	100%	11	92%	13	96%	24
Control IV	91%	11	71%	7	83%	18
Stress IV	56%	25	20%	15	43%	40
Strengths IV	41%	32	50%	6	42%	38
Fluids IV	100%	12	100%	12	100%	24
Design IV	91%	11	100%	1	92%	12
Mechanics IV	96%	24	83%	12	92%	36
Materials IV	86%	7	33%	6	62%	23

Table 3.10 BTech success rates 2008

	DUT	n	non DUT	n	Total	n
Refrig IV	96%	23	82%	11	91%	34
Control IV	100%	9	100%	5	100%	14
Stress IV	81%	16	80%	10	81%	26
Strengths IV	77%	35	36%	11	67%	46
Fluids IV	97%	32	100%	9	98%	41
Design IV	91%	11	78%	9	85%	20
Mechanics IV	71%	14	67%	6	70%	20
Materials IV	75%	12	0%	1	69%	13

Table 3.11 BTech success rates 2009

	DUT	n	non DUT	n	Total	n
Refrig IV	100%	12	73%	11	87%	23
Control IV	83%	18	33%	6	71%	24
Stress IV	81%	26	13%	8	65%	34
Strengths IV	71%	21	46%	13	62%	34
Fluids IV	95%	20	100%	7	96%	27
Design IV	83%	18	90%	10	86%	28
Mechanics IV	75%	20	43%	7	67%	27
Materials IV	60%	10	0%	2	50%	12

Table 3.12 BTech success rates 2010

	DUT	n	non DUT	n	Total	n
Refrig IV	89%	19	89%	19	89%	19
Control IV	91%	32	89%	9	90%	41
Stress IV	71%	24	36%	14	58%	38
Strengths IV	67%	30	33%	6	61%	36
Fluids IV	97%	37	80%	10	94%	47
Design IV	74%	27	33%	3	70%	30
Mechanics IV	86%	28	64%	14	79%	42
Materials IV	43%	30	0%	2	41%	32

Tables 3.9 through 3.12 show the success rates of the two different groups. The term 'n' is used to indicate the number of students in each particular group. The DUT students generally had good success rates, whilst the non DUT students had poor success rates interspersed with good ones. These results are summarised in Table 3.13 and shows the percentage point difference between the success rates of the two groups. Positive values denote the DUT students outperforming the non DUT and negative values denote underperformance. This table should not be read in isolation from the individual semester success rates tables because a number of the subjects, Materials IV in particular, had a small proportion of non DUT students.

Table 3.13 Percentage point difference between performance of DUT and non DUT students

	2007	2008	2009	2010	mean
Refrig IV	8	14	27	0	12
Control IV	19	0	50	2	18
Stress IV	36	1	68	35	35
Strengths IV	-9	41	25	33	23
Fluids IV	0	-3	-5	17	2
Design IV	-9	13	-7	41	10
Mechanics IV	13	5	32	21	18
Materials IV	52	75	60	43	58

It can be seen, from the mean column in Table 3.13, that on average the DUT students outperform the non DUT students in all subjects. In the 32 subject offerings (8 subjects over 4 semesters) the non DUT students outperform the DUT students only 5 times and never by more than 9 pp. The non DUT students underperform 24 times with a maximum of 75 pp. They also underperform by more than 20 pp on 14 occasions.

The majority of non DUT student are assumed to be from the Mangosuthu University of Technology (MUT). MUT is situated in Durban and offers a diploma in mechanical engineering but not a BTech. Any MUT graduate that wishes to register for a BTech, in Durban, would have to do so with the DUT. Non DUT students may have graduated from institutions in other part of the country and relocated to Durban for work or personal reasons. Unfortunately the MIS system does not record the institution from which non DUT students graduated, so it cannot be determined if the underperformance is linked to all non DUT students or just those from MUT.

Although the non DUT students underperform generally, the major underperformance centres on five subjects namely; Control IV, Mechanics IV, Stress IV, Strengths IV and Materials IV. The first four of these subjects are compulsory whilst Materials IV is an elective. The poor success rates for Material IV of non DUT students was not of major concern because students failing it could always pick up another elective. The poor success rates of the other four subjects cause many non DUT students to drop out or be academically excluded.

The prerequisite subjects, at the diploma level, for Control IV and Mech IV are Theory III. For Stress IV and Strengths IV it is Applied III. A possible cause of this poor performance was that the subject content in the offering of these prerequisite subjects at DUT and MUT are not aligned. If MUT students enter the BTech without the required prerequisite knowledge they would no doubt struggle. Meetings were set up between lecturers from the two institutions to better align their respective subjects. It is hoped that this process will lead to better success rates for MUT students registering for the BTech at DUT.

3.1.5 Effectiveness of Supplementary Examinations

Nine courses within the programme are continually assessed (CA) and do not have final examinations nor supplementary exams. Some of these may include an extra assessment that acts as a supplementary by allowing students an opportunity to improve their coursemark. These are recorded by the ITS within students' coursemarks and not as a separate supplementary assessment. The increase in success due to this cannot be calculated.

Table 3.14 Percentage point increase in success rates due to supplementary exams in S1

	Mech I	Electros I	mean	semsester pp increase
2007 Sem 1	7.5	11.0	9.2	2.6
2007 Sem 2	0.0	7.9	3.9	1.1
2008 Sem 1	2.3	6.6	4.5	1.3
2008 Sem 2	1.3	8.8	5.1	1.4
2009 Sem 1	1.4	-	1.4	1.4
2009 Sem 2	0.9	-	0.9	0.9
2010 Sem 1	4.5	-	4.5	4.5
2010 Sem 2	0.9	-	0.9	0.9

Electros I was moved from the S1 to the S3 level as of the first semester 2009. This means that prior to 2009 there were only two subjects where supplementaries were offered and afterwards only one. Table 3.14 shows pp increases for Mechanics I of between 0 pp to and 7.5 pp. Electros I pp increases are generally of a higher order, ranging between 6.6 pp and 11 pp. The column titled 'mean' shows the mean pp increase of the examinable subjects, and the column titled 'semester pp increase' is the increase in success across the whole semester attributed to supplementaries. This is understandably small because most subjects are continually assessed in S1.

Table 3.15 Percentage point increase due to supplementary exams in S2

	Mech II	Materials I	Thermos II	Strengths II	Fluids II	mean	semsester pp increase
2007 Sem 1	5.3	0	5.7	9.4	1.9	4.4	3.2
2007 Sem 2	7.6	7.0	2.7	7.9	1.4	5.3	3.8
2008 Sem 1	5.7	7.8	0.0	7.2	2.1	4.6	3.3
2008 Sem 2	2.1	16.0	8.1	1.1	4.7	6.4	4.6
2009 Sem 1	14.9	7.6	5.7	6.9	12.3	9.5	6.8
2009 Sem 2	2.9	0.8	2.0	3.0	8.8	3.5	2.5
2010 Sem 1	0	0.0	4.1	0.0	3.2	1.5	1.0
2010 Sem 2	3.6	0.0	1.7	0.8	3.5	1.9	1.4

The individual subjects in S2, shown in Table 3.15, all show a wide range of pp increases with a maximum of 16 pp. There are two CA courses at S2 hence the semester pp increase is less than the mean.

Table 3.16 Percentage point increase due to supplementary exams in S3

	Thermo III	Strengths III	Mechanics III	Eng Design III	Fluids III	Electros I	mean	semsester pp increase
2007 Sem 1	11.4	7.7	6.7	3.5	2.4	-	6.3	5.3
2007 Sem 2	2.4	1.8	3.7	2.0	2.0	-	2.4	2.0
2008 Sem 1	4.2	5.6	3.9	4.2	14.5	-	6.5	5.4
2008 Sem 2	5.4	12.5	4.7	0	0	-	4.5	3.7
2009 Sem 1	0	15.7	7.6	0	9.3	7.9	6.7	5.8
2009 Sem 2	4.4	3.8	8.3	5.0	7.8	10.3	6.6	5.7
2010 Sem 1	1.9	14.1	2.9	2.9	1.3	5.8	4.8	4.1
2010 Sem 2	7.4	23.1	11.1	16.7	9.2	6.6	12.3	10.6

The results shown for S3 in Table 3.16 are similar to those for S2 with a variable range of pp increases for individual subjects. There is one CA course at S3 so once again the semester pp increase will be less than the mean.

Table 3.17 Percentage point increase due to supplementary exams in S4

	Theory III	Steam Plant	Maths III	Hydraulics III	Applied III	mean	semsester pp increase
2007 Sem 1	6.9	0	11.1	0	19.7	7.5	6.3
2007 Sem 2	7.1	0	8.3	0	12.8	5.6	4.7
2008 Sem 1	6.1	11.8	3.0	0	0	4.2	3.5
2008 Sem 2	22.0	4.2	5.4	8.7	5.3	9.1	7.6
2009 Sem 1	16.3	17.0	17.6	9.3	2.6	12.5	10.4
2009 Sem 2	3.6	20.9	5.6	7.7	4.6	8.5	7.1
2010 Sem 1	2.0	22.7	8.2	10.0	0	8.6	7.1
2010 Sem 2	1.2	14.9	4.5	1.5	0	4.4	3.7

The results shown for S4 in Table 3.17 are again a variable range of pp increases for individual subjects. There is one CA course at S4 so once again the semester pp increase will be less than the mean.

Table 3.18 Percentage point increase due to supplementary exams (including CA courses)

	'07 sem 1	'07 sem 2	'08 sem 1	'08 sem 2	'09 sem 1	'09 sem 2	'10 sem 1	'10 sem 2	mean
S1	2.6	1.1	1.3	1.4	0.2	0.2	0.7	0.2	1.0
S2	3.2	3.8	3.3	4.6	6.8	2.5	1.0	1.4	3.3
S3	5.3	2.0	5.4	3.7	5.8	5.7	4.1	10.6	5.3
S4	6.3	4.7	3.5	7.6	10.4	7.1	7.1	3.7	6.3
mean	4.3	2.9	3.4	4.3	5.8	3.8	3.3	3.9	4.0

Table 3.18 collates the semester pp increases values from the four tables above. From here it can be seen that the effect of offering these supplementary exams on the programme is small

but not altogether insignificant. They increased the average success rate in the programme by between 2.9 pp and 5.8 pp across this eight semester period. The mean value increases from S1 to S4. Part of this is because there are more CA courses at the lower levels.

Table 3.19 Percentage point increase due to supplementary exams (excluding CA courses)

	'07 sem 1	'07 sem 2	'08 sem 1	'08 sem 2	'09 sem 1	'09 sem 2	'10 sem 1	'10 sem 2	mean
S1	9.2	3.9	4.5	5.1	1.4	0.9	4.5	0.9	3.8
S2	4.4	5.3	4.6	6.4	9.5	3.5	1.5	1.9	4.6
S3	6.3	2.4	6.5	4.5	6.7	6.6	4.8	12.3	6.3
S4	7.5	5.6	4.2	9.1	12.5	8.5	8.6	4.4	7.6
mean	6.9	4.3	4.9	6.3	7.5	4.9	4.8	4.9	5.6

Table 3.19 collates the mean values from Tables 3.14 through 3.17, interestingly the mean still increases from S1 to S4 even though the CA courses are included.

Although the supplementary examinations appear to have a small impact on the overall success of the programme, their effect is perhaps more valuable when students encounter difficulty with an individual examination. Out of 136 supplementary exams written over the period, 24 contributed over 10 percentage points to the subject's success rate. 4 of those 24 contributed over 20 percentage points to a subject's success rate. The fact that a large number of students fail the main exam and then pass the supplementary indicates that the students have gained sufficient knowledge over the course of the semester, but that for some reason found the main exam to be problematic. This situation may occur where an exam is particularly difficult, or where a number of exams are written close to each other.

The supplementary exams do not contribute greatly to the department's success rate, but at certain times they allow a significant number of students the opportunity to improve their results in an individual subject. In the absence of these supplementary exams a large number of students would have to repeat the subject the following semester. If the subject was compulsory, or a prerequisite for another subject, there would be a negative effect on graduation and throughput rates.

3.1.6 The impact of moving Electrotechnology I from S1 to S3

Table 3.20 Electrotechnology I success rates

	'07 sem 1	'07 sem 2	'08 sem 1	'08 sem 2	'09 sem 1	'09 sem 2	'10 sem 1	'10 sem 2
Mainstream	27%	25%	12%	13%	95%	80%	75%	83%
class size	113	76	131	88	38	44	60	63
Mechatronics	-	-	10%	21%	17%	79%	38%	82%
class size	-	-	20	14	24	14	29	11

Table 3.20 shows separate success rates for mainstream and mechatronics students registered for Electros I. Prior to the first semester of 2009 both groups took the subject at S1 and attended the same classes. From the first semester 2009 forwards the mainstream group took Electros III at the S3 level and the mechatronics group at S1. The groups, although at different levels, both attended the same classes making a comparison between success rates easy. The same lecturer took this course over the whole eight semesters with little or no change to the syllabus.

A steep increase in success in the mainstream group can be seen to coincide with the move to the S3. This group only included students who were repeating the subject. The first time new students took this course was the first semester of 2010. S3 students registering for this subject in the first semester of 2009 would be expected to perform well as they all had previous exposure to the course content and structure. As first time students entered the course in 2010 the success rate remained high implying that this is not the sole factor accounting for the increased success.

The mechatronics option, first offered by the department in the first semester of 2008, has only one intake of students per year, as opposed to the mainstream's dual intake. Because the subject is offered every semester any student that failed the subject in the first semester would repeat it the following semester. This goes some way to explain fluctuation in the success rates for the mechatronics students. The lowest success rates coincide with the first semester and the high success rates coincide with the second semester, where the group is comprised only of repeat students.

The disparity between the success rates for mainstream and mechatronics students in the first semester of each year, again gives credence to the position that S1 students do not possess the requisite academic skills to succeed in this course, as it is currently offered. Weaker students are excluded or drop out before reaching S3 and this must also be acknowledged as a contributing factor to the increased success later on.

At the time when this subject was moved there was debate as to whether this intervention would negatively affect the success rates of other S3 subjects due to an increased workload. It was however believed that a small reduction in the success rates at S3 would be justified if matched by a dramatic increase in the success rate for Electrotechnology I. As seen in section 3.1.2 the average success rate for S3 students remained fairly stable over the period, with this added work load seeming to show no effect of the success rates of the other S3 subjects.

3.2 Workplace Learning

Table 3.21 shows the pass rates for students registered for P1 for the period 2007 - 2010. The pass rate for first time registered students is low, with a mean of 52.4%. One of the reasons for this is the way that the University registers students for WPL. As mentioned previously WPL registration opens at the beginning of each semester and results are released at the end. Students that do not register for WPL within the first month of the semester would automatically 'fail' P1 as they would not have completed it by the end of the semester.

Table 3.21 P1 pass rates

	2007 sem1	2007 sem2	2008 sem1	2008 sem2	2009 sem1	2009 sem2	2010 sem1	mean
1st time registrations	44%	62%	57%	44%	69%	45%	46%	52%
Repeat registrations	100%	97%	100%	97%	83%	100%	88%	95%
Total pass rate	57%	78%	67%	63%	74%	55%	57%	64%
Percentage of repeat students	22%	47%	22%	35%	37%	19%	28%	30%

The pass rate of repeat students is significantly higher. It is near, or at 100%, for five out of the seven semesters. A pass rate for repeat students of 100% does not imply that all students complete P1 within two semesters. A number of students register for P1 and then remain in industry for a number of semesters before returning to register for and complete P2. The rate for repeat students reflects only those who re-registered; not those who remained in industry unregistered.

Table 3.22 P2 pass rates

	2007 sem1	2007 sem2	2008 sem1	2008 sem2	2009 sem1	2009 sem2	2010 sem1	mean
1st time registrations	47%	83%	72%	55%	60%	69%	53%	63%
Repeat registrations	100%	89%	100%	100%	82%	92%	88%	93%
Total pass rate	54%	84%	76%	65%	69%	74%	64%	69%
Percentage of repeat students	14%	15%	14%	23%	40%	20%	31%	22%

Table 3.22 shows patterns very similar to those in Table 3.21, with the pass rate for repeat registrations far higher than those of first time registrations. The average pass rate of first time registered P2 students is 11 pp higher than that of P1 students. This is expected because of the manner in which WPL is registered. For example a student that registered for P1 mid semester, and completed it six months later, would pass P1 at the end of their second P1 registration. They would have started their P2 upon completion of P1, in the middle of the second semester. The system would only show them as registered for P2 at the end of the second semester. Someone in this situation would then effectively have 9 months to complete P2.

To further understand the impact of WPL, the academic records of all students graduating between April 2009 and April 2011 were analysed. These results are tabulated under the relevant graduation period in Tables 3.22 through 28.

Table 3.23 Students completing all academic components before or during P1

	Apr-09	Sep-09	Apr-10	Sep-10	Apr-11
Completed before P1	51%	63%	53%	63%	57%
Completed by end P1	65%	63%	62%	70%	63%

Table 3.23 shows the percentage of students that have completed all academic components of the programme before starting P1. By and large, the majority of students do not return to the university after completing P1.

Also shown are the percentages that have completed all academic components of the programme by the end of P1. Students passing academic subjects during WPL include those taking advantage of the University's 'last outstanding subject' rule, those registered concurrently and those who registered at another institution (generally Unisa). The 'last outstanding subject' rule allows student who have failed the exam and/or sup to rewrite the exam in the following exam session provided they had a valid course mark. A number of students, who do not qualify for this exam, register for subject/s concurrently with WPL. They typically do not attend classes and return to the University only to write the tests and examinations. This contravenes departmental rules, but online registration does not prevent this concurrent registration.

Table 3.24 Percentage students returning to DUT after P1 and/or P2

Apr-09	Sep-09	Apr-10	Sep-10	Apr-11	mean
11.6%	12.5%	13.3%	18.5%	25.5%	16.3%

Table 3.24 shows the percentage of students that register for subjects at DUT after completing P1 and/or P2. These values exclude students who register for academic subjects concurrently with P2 and were not in attendance. If, on average, only 16% of students return to the academic programme after completing P1 and/or P2 the remaining 84% have no opportunity to integrate experience gained in the workplace with the classroom experience.

Table 3.25 Average no. of subjects completed by students during or after P1

	Apr-09	Sep-09	Apr-10	Sep-10	Apr-11
Mean	2.4	2.8	3.3	3.0	3.8
Std Dev	2.5	1.4	4.2	2.2	4.1
Median	2.0	3.0	2.0	2.5	2.0

To further determine the extent to which WPL allows the integration of work experience with the academic programme the average number of subjects completed during or after P1 was determined. Students, who engage with the academic programme after registration for P1, generally register for very few subjects, having already completed the majority beforehand. Table 3.25 shows that of these students the median only completes just over two subjects after their first WPL registration. The mean is generally higher than the median as each cohort included a limited number of students who completed a significant portion of their academic components after P1.

In order to graduate students need to have completed at least twenty four subjects. It is therefore apparent that even the minority of students who engage with the academic programme after WPL do so in a very limited manner.

Table 3.26 Number of semesters taken to complete P1 and P2

	Apr-09	Sep-09	Apr-10	Sep-10	Apr-11
Mean	3.2	3.5	3.1	3.6	3.6
Median	3	3	2	3	3
Min time	42%	28%	51%	37%	49%

Table 3.26 shows the average number of semesters a student takes to complete the full WPL portion of the programme. WPL should be completed within two semesters but the mean is above 3 in all instances, negatively impacting the programme throughput rates. It is worth noting that the marginal increases to the means, calculated from the September 2010 to the April 2011 graduation periods, was caused by the inclusion of a few students that had taken over ten semesters to complete WPL. If these few exceptions are ignored, the mean for these two periods become 3.3 and 3.0 respectively.

Table 3.27 WPL registrations semester 1 2007 to semester 1 2010

	1st Time Registrations	Total Passes	Dropout
P1	391	364	7%
P2	341	313	8%
P1 & P2 combined	391	313	20%

Due to the significant variation in first time registrations each semester, and the large number of repeating students, it was difficult to determine dropout rates for any particular semester. Total first time registrations and total passes for the seven semesters were utilised to estimate the dropout rate. Table 3.27 shows the total number of students registering for P1 and P2 as well as the number of passes in that period.

As mentioned, the dropout rate is an estimation only, as it does not take into account growth in numbers over the period. The average growth rate for first time registrations over this period was 4% therefore any inflation of dropout rates due to growth can be assumed to be minimal.

It is also feasible that some students return to the university between P1 and P2 and are then excluded academically, due to poor performance. As seen previously the majority of students have either completed all, or the majority of the academic programme before embarking on WPL. It is therefore unlikely that academic exclusions play a significant part in the dropout rate. These dropouts are of concern; having completed the majority of the academic programme students that dropped out at this point were likely close to graduating.

Lecturers that teach both BTech and diploma level subjects suggest that there is a marked improvement in the maturity, commitment and general attitude of BTech students as compared to diploma students. They also have suggested that these students tend to grasp the material covered in courses more easily as they may have already had ‘hands on’ experience with the technologies/concepts covered in class. Although this is anecdotal it would still suggest that WPL is still partially meeting its intended outcomes. It may be adding little value to academic portion of the diploma programme but it would appear that some of the intended outcomes such as increased maturity, development of communication skills and an increase in learning retention, are being met, even if only after the academic portion of the programme has been completed.

As the supposed benefits of WPL are not having a significant effect on the academic portion of the diploma, it could be argued that it would be more efficient if the current offering of WPL was removed from the programme. The perceived benefits mentioned above could be achieved by simply adding an entrance requirement to the BTech programme of at least one year post diploma work experience. A more reasonable solution would be to revise the manner in which WPL is offered to ensure that it is offered in an effective and beneficial manner if included in new programmes developed under the new HEQSF.

3.3 Relationship between NSC results and success in mechanical engineering

3.3.1 Pilot Study

The correlations shown in Table 3.28 ran counter to expectation. English 1st language scores showed a weak correlation with Materials 1 scores, whilst English 2nd language showed no correlation. The weak correlation shown between English 1st language and Materials 1 is unlikely to be a major causal factor. Students who performed well in all of their NSC subjects, including English probably perform well in all their University subjects.

Following this it was decided to investigate whether NSC Mathematics and NSC Physical Science results showed any correlation with Materials I results. These are also shown in Table 3.28. There was a medium correlation between NSC Mathematics and Material Science I for English 2nd Language students.

Table 3.28 Materials I results and NSC results

	NSC English	NSC Physics	NSC Maths
1st language students	0.287	0.230	0.2846
2nd language students	0.084	0.252	0.425

Because there were no strong correlations the study was broadened to include Mathematics I and Mechanics I. These subjects were chosen as they historically have poor success rates. It was assumed that NSC English, Maths and Physics would all show a significant correlation with Maths I and Mechanics I. Table 3.29 shows that once again, counter to expectation there was no correlation between English and Maths I and Mechanics I.

Table 3.29 Correlations between NSC English results and Maths I and Physics I results

	Maths I	Mechanics I
1st language students	- 0.025	0.178
2nd language students	0.057	- 0.012

Stronger correlations were found between NSC Maths and Physics and Mechanics I and Maths I and these were included in the full study.

3.3.2 Full Study

Table 3.30 Correlations between NSC results and Mathematics I results

	Sem1 '09	Sem2 '09	Sem1 '10	Sem2 '10	Sem1 '11	weighted ave
NSC Math	0.43	0.18	0.55	0.43	0.60	0.54
NSC Physics	0.22	0.32	0.37	0.66	0.43	0.38
NSC Maths + Physics	0.39	0.25	0.54	0.68	0.59	0.54
sample size	26	17	86	27	93	249

Table 3.30 shows that NSC Mathematics results correlate strongly with those of Mathematics I. There is also a medium correlation between NSC physics and Mathematics I. As expected the correlation between NSC Maths and Mathematics I is stronger than that NSC Physics and Maths I. Surprisingly the combination of the NSC results shows as strong a correlation as that of NSC Maths by itself.

Table 3.31 Correlations between NSC results and Mechanics I results

	Sem1 '09	Sem2 '09	Sem1 '10	Sem2 '10	Sem1 '11	weighted ave
NSC Math	0.33	0.55	0.46	0.41	0.42	0.43
NSC Physics	0.33	0.43	0.38	0.40	0.44	0.40
NSC Maths + Physics	0.37	0.54	0.48	0.48	0.50	0.48
sample size	26	17	92	29	91	255

Table 3.31 shows a medium correlation between all NSC results listed and Mechanics I. NSC Maths shows approximately the same correlation with Maths I and Mechanics I as NSC Physics. The combination of the NSC Maths and Physics shows a stronger correlation that of the individual subjects.

Table 3.32 Relationship between NSC Physics and Mathematics I and Mechanics I success

NSC Physics %	Mathematics 1 Success	Mechanics 1 Success	% of cohort
50 - 54	49%	33%	30%
55 - 59	61%	48%	23%
60 - 64	58%	48%	18%
65 - 69	69%	67%	14%
70 - 74	60%	62%	6%
75 - 79	88%	89%	6%
80 - 100	71%	70%	3%

n= 249

Table 3.32 shows students' performance in NSC Physics and the corresponding success rates for Mathematics I and Mechanics I. As expected, the higher the students' results for Physics the greater their success in Mathematics I or Mechanics I. The range of success for Mechanics I is greater than that for Maths I, with lower performing NSC students performing worse in Mechanics than they do in Maths I. However, students with more than 65% for physics perform equally well in both S1 subjects.

Table 3.33 Relationship between NSC Mathematics and Mathematics I and Mechanics I success

NSC Maths %	Mathematics 1 Success	Mechanics 1 Success	% of cohort
50 -54	14%	14%	9%
55 - 59	36%	35%	9%
60 - 64	41%	40%	15%
65 - 69	55%	44%	17%
70 - 74	71%	57%	18%
75 - 79	76%	64%	15%
80 - 100	93%	74%	18%

n = 249

Table 3.33 shows students' performance in NSC Mathematics and the corresponding success rates for Mathematics I and Mechanics I. In contrast to the results for Physics, the results for NSC Maths at the lower levels are near identical for both subjects, but diverge at the higher level. The success rates, for both Maths I and Mech I, are much worse for students with low NSC Maths scores than they are for those with low NSC physics scores.

What is interesting is the distribution of NSC Maths and NSC Physics results across the bands. 30% of students admitted have between 50 and 54 for Physics yet only 9% fall into the same band for Maths. Generally students entering the programme have weaker results for NSC Physics than they do for NSC Mathematics. Further, 53% of the students had less than 60% for Physics but only 18% had less than 60% for NSC Mathematics. Conversely only 15% of the students had 70% or more for Physics, whilst 51% had 70% of more for Mathematics.

Table 3.34 Relationship between NSC results and Mathematics I and Mechanics I success

NSC marks Maths + Physics	Math 1 success	Mech 1 Success	% of cohort
<110	31%	25%	11%
110 – 119	36%	27%	19%
120 -129	66%	52%	23%
130-139	57%	51%	19%
140-149	77%	62%	14%
150-159	89%	89%	11%
160- 200	100%	90%	4%

n = 249

From Table 3.34 it can be seen that students with a combined NSC score of less than 120 have extremely poor success rates. These students currently make up 30% of the intake.

3.3.3 Further Study

Table 3.35 shows the relationship between the combined NSC and Maths and Physics results of the 2010 Semester 1 cohort and success within the programme. All results are as expected; the higher the students NSC results, the better the respective indicators of success.

Table 3.35 Relationship between NSC results and Success (Cohort Sem 1 2010)

NSC marks Maths + Physics	Completed programme (ex WPL)	Dropped out or excluded	Semesters taken to complete	Subjects passed per semester	Subjects failed per semester	% of cohort
100 - 119	22%	63%	6.7	3.0	2.1	30%
120 -129	50%	42%	6.6	3.4	1.8	29%
130-139	66%	33%	6.1	3.4	1.9	20%
140-149	75%	25%	5.7	4.0	1.3	13%
150 - 200	86%	14%	5.3	4.7	0.9	8%

n = 90

The students with the lowest NSC results predictably show the highest dropout or exclusion rates. The difference between the columns entitled "Dropped out or excluded" and "Completed programme (ex WPL)" would be the percentage of students that may still complete the programme during the course of 2014. Of those that have completed the academic programme, those with higher NSC results do so in fewer semesters than those with lower results.

The number of subjects passed and failed per semester was calculated using results from the entire cohort, not just those that had completed the academic component. Again those with higher NSC results predictably pass more and fail less than those with lower results.

3.4 Investigation into causes of poor performance in Hydraulic Machines III

3.4.1 Analysis of assessments

Table 3.36 Student performance in 1st semester 2012 exam, ranked by score per question

Question	Question type	Difficulty	Full marks	Average score
3b	Conceptual/theory	3	5	17%
1b	Conceptual/theory*	2	6	21%
4b	Conceptual/theory	2	10	29%
1a	Calculation*	3	12	30%
2b	Conceptual/theory	1	8	38%
2a	Calculation#	4	12	48%
5a	Calculation	5	22	59%
4a	Calculation	2	12	80%
3a	Calculation	2	15	86%

Average exam mark = 53%, pass rate = 62%, n =78 students
* hydraulic machines # Pelton wheel

It can be seen, from Table 3.36, that students performed much better in calculation based questions than they did in conceptual or theory based ones. The worst performance for a calculation based problem was question 1a. The question was based on the hydraulics machines section of the syllabus, the last section covered in class. The conceptual/theory question associated with it, question 1b was also answered very poorly.

It had been noted that in previous exams many students would not attempt to answer the hydraulic machines question at all. It was assumed that students did not prepare adequately for this section as it was the last covered in class. It would not have been assessed in any class tests and so if students were under pressure as the exam approached it was assumed that they may opt to spend less time on this section and concentrate on sections they were more familiar with.

In the second semester of 2012 the hydraulics section was moved to an earlier slot in the semester, such that it would now be assessed in a class test as well as the exam. It was thought that by including this section in a class test that it would help students to prepare for the examination and that they would achieve better results than previously. It was of concern that students may consequently perform worse in the Pelton wheel section which would now be the last section.

Table 3.37 Student performance in 1st major test 2nd semester 2012

Overall average	Calculations	Theory/Conceptual	Pass rate	Number of students
44%	57%	9%	30%	74

Performance in the first test of Semester 2 2012 was not analysed on an individual question basis, but only according to performance in calculation or theory/conceptual questions. From Table 3.37 it can be seen that performance in calculation questions once again exceeded performance in theory/conceptual questions.

Table 3.38 Student performance in 2nd major test 2nd semester 2012

Question	Question type	Difficulty	Full marks	Average score
1 iii	conceptual/theory *	1	2	13%
1 ii	calculation *	1	3	21%
1 i	calculation/theory *	3	8	23%
2	calculation	2	16	44%
3	calculation	2	20	59%

Average exam mark = 43%, pass rate = 39%, n =71 students

* hydraulic machines

Table 3.38 shows particularly poor performance in question 1 of the second major test. The conceptual questions all relate to the hydraulic machines section. Those questions along with the calculation question relating to the hydraulic machines section are once again the section in which the students performed the worst. It had been noticed that many students would ignore the conceptual or theory questions completely. To measure the extent of this it was decided to record whether questions were attempted or not for the second semester examination.

Table3.39 Student performance in 2^{st} semester 2012 exam, ranked by score per question

Question	Question type	Difficulty	Full marks	Average score	Did not attempt
7a	Calculation *	3	8	8%	72%
2b	Conceptual/theory	1	8	18%	44%
2a	Calculation	2	12	22%	39%
6b	Conceptual/theory	2	4	25%	52%
7b	Conceptual/theory *	1	4	29%	43%
4b	Conceptual/theory	3	4	32%	39%
1	Calculation#	2	10	43%	10%
6a	Calculation	2	13	50%	8%
3	Calculation	2	13	58%	2%
4a	Calculation	3	12	60%	5%
5	Calculation	2	13	61%	0%

Average exam mark = 42%, pass rate = 25%, n =61 students

*hydraulic machines # Pelton wheel

From Table 3.39 it can be seen that once again the results achieved for conceptual or theory questions are below that of most calculation questions. Contrary to expectation the results achieved for the hydraulic machines calculation were the worst of all. It had been expected that students would perform better in this section. Some possible causes will be discussed later.

As expected student performance in the Pelton wheel question was worse than in the previous exam (43% as compared to 48%) even though the question was deemed to be significantly easier.

The results for question 2a (reaction turbines) are quite interesting. It was a very basic question with all calculations being very similar to those in tutorials and past papers. The only difference was that the turbine blade geometry was forward curved instead of backwards curved. Students are usually required to sketch a blade velocity diagram before starting calculations. In this question a full diagram was included to eliminate any possible confusion. It was not assumed that this question would be problematic as students should be familiar with forwards curved blades as they are covered in the fans and fans systems section as well as the centrifugal pump section.

Large number of students did not attempt this question at all. Of those that did, a large number chose to redraw the diagram to one representing a backwards curved blade. Instead of applying theory, mostly basic trigonometric identities, to the correct diagram they chose to apply it to their own diagram. This explains the poor performance in this question, but also sheds light on the tendency to follow a 'recipe' to solve a problem. If the problem changes slightly the students cannot see that the 'recipe' needs to change too. In fact they tend to adapt the question to the recipe. It may also be seen that most calculation questions were attempted by virtually all students whereas theory/calculation questions showed much smaller likelihood of being attempted.

3.4.2 Analysis of online usage

The Moodle platform allows for accurate logging of all student activity on the website. 70% of the class logged onto the online platform at least once. An analysis of the resources they utilised whilst logged on provides further insight. Table 3.40 shows the utilisation of these resources by the class.

Table 3.40 Usage of online resources

example 1	example 2#	example 3*	video 1	video 2	practical feedback	practical timetable	study guide/tut book	pump quiz
34%	15%	7%	14%	18%	51%	38%	38%	41%

* hydraulic machines # Pelton wheel n = 74

Students utilised the site mainly for administrative functions such as viewing their marks for practical reports or downloading the study guide. Resources allocated for learning, such as worked examples and videos, were generally poorly utilised. It can be seen that only 7% of the students accessed example 3 for the section hydraulic machines. This section was added to provide extra worked examples as the results of the analysis of students' assessments showed that they always underperformed in this section, as mentioned previously.

Although students were also asked to watch video 1 as the content therein would be covered in a minor test, only 14% of students logged in to view it. The pump quiz had the highest utilisation of any of the non-administrative content. Students were also told that the contents of this would be covered in a minor test. This test was held after the test containing the questions based on the video. This may explain why there was higher utilisation.

The results above need to be interpreted in context. The Moodle website logs visits by individual students to each resource on the site. If two students watched a video together Moodle would obviously registered only the details of the student that had logged in.

In an attempt to gain clarity on the above, students were requested, in class, to complete a short survey. The survey was not anonymous and so it must be considered that this may have had an outcome on the responses. 61 students, out of a possible 75, participated and of those 8 (13%) stated that they did not utilise the online platform and thus did not answer any further questions. They are therefore not included in Tables 3.40 and 3.41.

Eleven students answered either (a), (b) or (c) to question 1 but had never logged onto the website as recorded by the website log. The only possibility for a student to have accessed material on the platform, but to never have logged in was if they had always accessed it as part of a group. The responses of these 11 students were deemed to be invalid and are thus not reflected in Tables 3.41 and 3.42.

If we combine the 8 students that acknowledged not using the site with the 11 excluded above, then we see that 19 (31%) of the 61 respondents did not use the site at all. As stated earlier, from accessing the website log, it was found that 30% of students had never logged onto the site. This is not far from the 31% mentioned above. Although this is not a statistical measure of validity it gives some confidence in the rest of the responses in Table 3.41 and 3.42.

Table 3.41 Response to the question 1: “When I use the website I access it …”

answer	no of respondents	percentage
(a) always by myself	37	88%
(b) sometimes in a group	4	10%
(c) usually in a group	1	2%
(d) always in a group	0	0%
		n = 42

The results shown in Table 3.41 above can be used to put the usage of the online resources in Table 3.40 into context. The majority of students access the website alone. It is thus reasonable to infer that whilst utilisation of online resources would be higher than that shown in Table 3.40, due to students accessing the resources together, it is unlikely to be dramatically higher.

Some of the resources such as examples and solutions are saved on the site as pdf files and it is therefore very easy for students to distribute these to their peers who may not have logged on. Table 3.42 shows the responses to question 2, which was designed to determine the extent to which this took place.

Table3.42 Response question 2 “when using the examples/solutions posted on the website…”

	answer	no of respondents	percentage
(a)	I have not looked at the examples/solutions online	8	19%
(b)	I have shared this information with classmates electronically	7	17%
(c)	I have shared this information with classmates via hardcopy	13	31%
(d)	I have shared this information with classmates electronically and via hardcopy	2	5%
(e)	I have not shared this information with other students	12	29%

n = 42

From Table 3.42 it can be seen that 19% of respondents did not look at any examples online. This implies that the remaining 81% accessed at least on example online.

By checking the website log it was found that 39 students or 75% of those who visited the website accessed at least one example. This is not far off from the 81% above. Although not a statistical measure of validity it again gives confidence in the rest of the responses in Table 3.42.

3.4.3 Student interviews

The predominant study method utilised by these students was to work through past test papers. Test papers were chosen over exam papers due to the availability of full model answers. On the whole prescribed tutorials were not attempted; the reasons given by most students were “*these have no answers”*.

The tutorials however were all provided with answers; many even included a guide as to how to best approach the problem. What the students mean is that they lack a full solution. What is of concern is that no real work is done by these students. They may believe that they are learning by working through past papers, but by doing so may be limiting their learning to a form of pattern recognition. If this is the case, they may not grasp the context or the applicability of the subject matter.

One student showed a booklet where he had copied, by hand, both the questions and solutions from multiple past test papers. When asked why he did this when he already had copies of the original test papers, he stated that it helps him to memorise the questions in case they appear in a test or exam.

Eight of these students admitted to doing no preparation at all for the hydraulics machines section. The reason given by all was that there were no past papers with solutions. When asked why they did not use the online examples and solutions the response can be summed up in the words of one student "*it's how we learn, we do past papers, we don't go online*". When asked why they did not utilise the other online resources such as videos and quizzes the consensus was that they did not see any value in doing this '*extra work*'.

All of the students indicated that they would attempt calculation problems before attempting theory/conceptual questions. A minority even admitted that even if the theory questions were very easy they would not know as they would not read the question until they had answered all calculations questions first. When questioned as to why he didn't engage with the conceptual questions one student replied "*our minds are not programmed to think like that*".

Perhaps a self-reinforcing loop may be present within the department. If in lower level subjects a student is expected to answer only calculation questions, the weaker student will practice calculations at the expense of understanding the context and applicability. By the time he reaches final level subjects he has developed, up until this point, a 'successful' method of study.

Chapter 4

Conclusions

4.1 Overview

This thesis details four areas of study that were undertaken in an attempt to identify potential impediments to student success in the Department of Mechanical Engineering at the Durban University of Technology. The use of a grounded action methodological framework was beneficial as it allowed the results of a particular study, or part thereof, to inform the direction and design of the next one. Although by no means comprehensive, a number of scenarios were examined and their impact on student success analysed. The knowledge obtained from these investigations, as outlined below, will prove useful to the department as it endeavours to improve the offerings of its current programmes, and develops new programmes.

4.2 Analysis of trends in student success rates

There was no substantial change to success rates following the introduction of the NSC. It can therefore be concluded that the entrance requirements chosen for the selection of NSC students, together with the addition of a geometry module, ensured that NSC students admitted to the programme had much the same competencies as the previous senior certificate students. Student success in both Mathematics I and Mechanics I prior to, and after, the admission of NSC students is generally poor, suggesting the entrance requirements, although similar, may not have been appropriate. This supports Wolmeraans et al.'s (2010) supposition, mentioned in the literature survey, that the poor performance of students in their study was not due to the introduction of the NSC but due to deterioration in the preparedness of the incoming first-year students. The appropriateness of the new entrance requirements is discussed later in Section 4.4.

The reduction in contact time in the programme had no measurable effect on the S2 and S3 levels and is assumed to have had no effect on the S1 and S4 levels. From this one can conclude that the department was 'overteaching' and that the reduction in contact time was appropriate.

The removal of electives negatively affected success rates at the S4 level. This was expected, as students that found difficulty with a particular subject could previously avoid it by utilising credits gained from the pool of electives. The removal of these electives was done in order to increase throughput in the BTech and further research will be able to determine if this was the case.

Students with diplomas from other universities, mainly MUT, enrolled in the BTech were found to underperform their DUT peers by a number of measures. Underperformance was concentrated in five subjects and it is theorised that there is a misalignment in the subject content of the prerequisite diploma subjects in the DUT and the MUT offerings.

Supplementary examinations have played a small, but in certain instances, valuable contribution to success rates, and this practice should be extended to include more, or all, students who fail after writing the final examination.

Analysing success rates, in a longitudinal study similar to that conducted by Ohland et al (2004), mentioned in the literature review, led to the identification of Electrotechnology I as a critical bottleneck. The subsequent intervention staged by moving Electrotechnology I to S3 was successful with improvement in success rates for the mainstream students exceeding all expectations. The mechatronics students' results allowed direct comparison to the mainstream students' and further affirm that the improvement correlates with the move of the subject to the higher level. It is most likely that the under preparedness of students leaving school is such that they cannot cope with the demands of this subject at the lower level.

4.3 Workplace Learning WPL

WPL in its current form is not meeting its intended outcomes as the majority of students have no opportunity to integrate experience gained in the workplace with the classroom experience. It also sees a significant number of academically capable students drop out, and those that do graduate take longer than necessary to complete WIL, thereby negatively affecting the department's throughput rates. Measures have been put in place to regularly contact WPL students to encourage them to submit logbooks timeously, reducing the average time students are registered for WPL.

4.4 Relationship between NSC results and success in Mechanical Engineering

Although the reliability of using NSC results as a predictor of success has been brought into question by a number of authors, mentioned in the literature review, the results in this thesis show that combined NSC Maths and NSC Physics results can be reasonably effective predictors of success, or lack thereof, in Mechanical Engineering at DUT. From both the full and further studies it can be seen that students with a combined NSC scores of less than 120 for Maths and Physics perform poorly. Their success rates in the major S1 subjects are far below that of their peers. From the further study it is shown that the higher the students combined NSC score the better they perform by a number of measures. The true measure of success is completion of the programme. A full 63% of students that had a combined NSC score of less than 120 left the programme before completion. A further 15% had not completed within the expected time.

Entrance requirements, should ensure that students admitted into the programme have a reasonable chance of success. Allowing students with little chance of success into the programme is both unfair to the students and detrimental to the department. The department's entry requirements should be changed to include a minimum combined score for NSC Mathematics and NSC Physics of 120. Failing this, interventions should be put into place to support student with a score of less than 120.

4.5 Investigation into causes of poor performance in Hydraulic Machines III

Tracking the performance of students in individual questions proved to be useful. It highlighted clearly where problems lay. The major challenge would appear to be the students' inability to deal with conceptual and theory questions. The section 'hydraulic machines' was also identified as being problematic. It was attempted to mitigate this by moving the section to earlier in the syllabus but this had no real affect. It is likely that this was because there were no past papers with solutions available.

Analysis of the usage of online resources showed that student usage of these resources was low. Specific interventions that were put in place to help with the problems highlighted above were not successful as there was limited student interaction. In the future a means of ensuring that students better utilise online resources should be developed or differ net interventions should be tried.

The interviews held with students were successful in shedding light on possible reasons behind students' lack of success. It would appear that, with weaker students, there is a culture of working mainly with past test papers and not doing any of the assigned tutorials. These students that passed lower level subjects mainly by practicing past test papers now faced tremendous difficulty as more is expected of them at higher levels. Further research and a change in teaching methods and assessment practices, within the subject and the department as a whole, are needed to address these concerns.

Chapter 5

Future Work

Since the start of this study the Department of Basic Education has introduced the Curriculum and Assessment Policy Statements (CAPS). CAPS is not a new curriculum, but an amendment to the current curriculum. The move to CAPS may mean that this study does not accurately reflect the current, and future, cohort of students and further research should be undertaken to determine the effect of this amended curriculum on student success. It would also be beneficial to extend this type of study to the whole faculty.

The move of Electrotechnology I to S3 for the mainstream students has seen a striking difference in success between them and the mechatronics students. These two separate cohorts are taught in the same classroom at the same time and further research to establish the causal factors behind this differential should be undertaken.

The decrease in success in certain S4 subjects, seen in section 3.13, due to the removal of electives was noted and the department is changing its curriculum structure to ameliorate this. The department has added additional major subjects to the BTech. The result is that, from 2016, diploma and BTech students will have a wider pool of major subjects to select from. It is hoped that this will lead to greater throughput as students select majors that best suit their strengths and interests. Research should be undertaken to determine if these changes positively affect the throughput of both programme.

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