

https://dspace.org/

Determining the predictors for success in engineering studies

Maraschin, Alessandra Chiara

2020

https://hdl.handle.net/10539/30385

Maraschin, Alessandra Chiara (2020) Determining the predictors for success in engineering studies, University of the Witwatersrand, Johannesburg, <http://hdl.handle.net/10539/30385>

Downloaded from a DSpace repository. https://dspace.org/

DETERMINING THE PREDICTORS FOR SUCCESS IN ENGINEERING STUDIES



UNIVERSITY OF THE
WITWATERSRAND,
JOHANNESBURG

Author:

Alessandra Chiara Maraschin

Supervisor:

Prof. Estelle Trengove

A dissertation submitted to the Faculty of Engineering and the Built Environment, University of Witwatersrand, Johannesburg, in fulfilment of the requirements for the degree of Master of Science in Engineering.

Declaration

I declare that this dissertation is my own unaided work. It is being submitted to the degree of Master of Science in Engineering to the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination to any other University.

Signed:

_____

Date:

_____

Dedication

To my family, this work would not have been possible without your love and support throughout my school and university career. Thank you for your ongoing encouragement and always helping me grow and become the best that I can be.

Acknowledgements

I would like to thank Professor Estelle Trengove for her continued guidance and support throughout this project. Thank you for introducing me to Engineering Education, you ignited my passion for education, and I will always remember this. I am so grateful for being able to have carried out research in a field so close to my heart.

I would like to acknowledge the South African National Research Foundation (NRF) for the funding to carry out this project, without which I would not have had the opportunity to study my Master's.

I would like to thank Craig Carlson for providing me with invaluable feedback on my research.

Lastly, I wish to extend my gratitude to all my family, friends and colleagues. Thank you for the exciting conversations about my research and for all being so interested in the findings of my work.

Abstract

There is a need to explore factors affecting student performance since the need for skilled engineering graduates is high. The problem is that the 4-year throughput rate in engineering in South Africa is 21%, and after 6 years a total of only 50% of students graduate. There is a lot of literature showing the quantitative side of this problem, but there is very little research performed using qualitative methods. The purpose of this research was to determine which factors could affect academic performance in engineering studies from the students' perspective at a South African University. This was achieved by using Glen Fisher's work as the framework. A mixed-methods approach was used, with the archive academic results and surveys yielding the quantitative results, and thematic analysis of focus groups yielding the qualitative results. The initial research population was 917 students, the survey included 411 respondents of which 353 participants chose to take part in focus groups. The final sample size for the focus groups was 35 participants. Thematic analysis showed that certain reasons for choosing the degree; the student's support system; the adjustment to university; and living far from university were factors perceived by students as affecting their performance negatively. It was also observed that studying in groups; making use of the Academic Development Unit; and attending lectures were perceived by students as affecting their academic performance positively. Some factors that appeared in literature did not emerge through the focus groups as affecting the academic performance, namely second language English; and funding.

Table of Contents

Declaration ..... **i**

Dedication ..... **ii**

Acknowledgements ..... **iii**

Abstract ..... **iv**

Table of Contents ..... **v**

List of Tables ..... **xi**

List of Abbreviations ..... **xii**

Chapter 1 Introduction **1**

1.1 Problem Statement **2**

1.2 Research Questions **2**

1.3 Research Objectives **2**

1.4 Dissertation Structure **3**

1.5 Conclusion **4**

Chapter 2 Contextualising Academic Performance in South Africa **5**

2.1 Engineering Education Background 5

2.1.1 Engineering as a Critical Skill 5

2.1.2 Bachelor of Science in Engineering in South Africa 6

2.2 South African Graduation Rate Statistics 7

2.2.1 4-Year Engineering Degrees 8

2.2.2 School of Electrical and Information Engineering Statistics 10

2.3 Three Cohorts in the School of Electrical and Information Engineering 11

2.4 Conclusion.....15

Chapter 3 Factors Affecting Academic Performance in University 16

3.1 Research Framework.....16

3.2 Reasons for Pursuing Engineering 20

3.3 Student Background 23

3.4 Gap between School and University 27

3.5 Financial Aid 29

3.6 Support Structure 30

3.7 Academic Results as Factors for Success 32

3.8 Conclusion.....34

Chapter 4 Research Methods and Methodology 36

4.1 Ethical Considerations.....36

4.2 Methodology Overview.....38

4.2.1 Research Methods' Alignment with Research Purpose.....39

4.3 Researcher's Role in the Research 40

4.4 Mixed Methods: Explanatory Research 41

4.5 Quantitative Sub-system.....42

4.5.1 Self-Completion Questionnaire.....42

4.5.2 Archive Academic Data 45

4.6 Qualitative Sub-System 46

4.6.1 Research Population.....47

4.6.2 Focus Group Sample.....49

4.6.3 Focus Group Process.....51

4.6.4 Focus Group Transcribing and Analysis.....54

4.7 Research Validation, Reliability and Replicability 57

4.8 Conclusion.....59

Chapter 5 Questionnaire Results 60

5.1 Survey Sample 60

5.2 Language Medium Results 61

5.3 Living and Travel Arrangements 62

5.4 Financial Aid 63

5.5 Conclusion.....65

Chapter 6 Focus Group Results.....66

6.1 Student Interest.....67

6.1.1 Subject Interest and Excellence 69

6.1.2 Family/Friend Influence.....74

6.1.3 Student Disinterest 75

6.2 Adjustment to University 77

6.2.1 Adapting to a New Environment: The School to University Gap 78

6.2.2 Financial Aid.....82

6.2.3 School: A Nurturing Environment.....82

6.2.4 Types of Schooling 83

6.3 Support in All Forms 85

6.3.1 Emotional Stressors.....86

6.3.2 External Stressors.....89

6.3.3 Support Success Strategies.....91

6.4 Limitations of the Research 97

6.5 Conclusion.....98

Chapter 7 Conclusion.....100

7.1 Recommendations and Future Research 102

7.2 Conclusion.....104

References 107

Appendix A Ethics Approval Documents.....113

A-1 Introduction.....113

A-2 Permission from Deputy Registrar.....114

A-3 Permission from Head of School.....115

A-4 Ethical Clearance Certificate 116

Appendix B Questionnaire Process.....117

B-1 Introduction.....117

B-2 Consent Form for the Questionnaire 117

B-3 Questionnaire for Focus Group Sampling.....119

Appendix C Focus Group Questions 121

C-1 Introduction.....121

C-2 Focus Group Questions/Topics 121

List of Figures

Figure 1: The distribution of Matric marks for Home language English. 13

Figure 2: The distribution of Matric marks for First Additional/2nd language English. 13

Figure 3: The distribution of Matric marks for Mathematics. 14

Figure 4: Showing the distribution of Matric marks for Physical Sciences. 14

Figure 5: A flow diagram of the final research approach. 38

Figure 6: The focus group process. 47

Figure 7: The research population for the focus groups. 48

Figure 8: The overall demographic of the gocus group attendees. 51

Figure 9: A block diagram showing the process of how the sample was filtered. .52

Figure 10: The flow chart of the thematic analysis process for the focus group analysis. 56

Figure 11: Participant language medium at school. 62

Figure 12: Percentage of students that live in Residence and those that live off campus. 63

Figure 13: The time students spent travelling to university (one-way). 63

Figure 14: The percentage of students that have financial aid and those that do not have financial aid. 64

Figure 15: Showing the approval letter from the Deputy Registrar. 114

Figure 16: Showing the approval letter from the Head of School. 115

Figure 17: Showing the ethical clearance certificate. 116

List of Tables

Table 1: The percentage of Engineering graduates after 4, 5 and 6 years after initial enrolment from government universities throughout South Africa (excluding UNISA). 9

Table 2: The percentage of Engineering graduates after 4, 5 and 6 years after initial enrolment from the School of EIE at University of the Witwatersrand. 11

Table 3: The overall demographic sample of the completed surveys. 61

Table 4: The number of students for each sub-theme in the theme of *Student Interest*. 69

Table 5: The number of students for each sub-theme in the theme of *Adjustment to University*. 78

Table 6: The overall sub-themes along with the frequency in the theme of *Support*. 86

List of Abbreviations

NRDS	National Research and Development Strategy
CHE	Council on Higher Education
EIE	Electrical and Information Engineering
Wits	University of the Witwatersrand, Johannesburg
SET	Science, Engineering and Technology
DHET	Department of Higher Education and Training
BSc Eng.	Bachelor of Science in Engineering degree
ADU	Academic Development Unit
FEBE	Faculty of Engineering and the Built Environment
UJ	University of Johannesburg
IT	Information Technology
HEQSF	Higher Education Qualifications Sub-Framework
PCA	Principle Component Analysis
HREC (non-medical)	Human Research Ethics Committee non-medical
AP	Advanced Programme

Chapter 1

Introduction

Skilled engineers are crucial to the functioning of society, and according to the National Research and Development Strategy (NRDS), South Africa is not producing enough engineers (The Government of the Republic of South Africa, 2002). The NRDS details the need for further developing the country (The Government of the Republic of South Africa, 2002). The aim of the NRDS is to educate citizens in fields which will enrich the country and its economy with an overall goal to reduce poverty.

The NRDS specifies that the throughput from Engineering is low. The Council on Higher Education (CHE) has published reports showing that for all branches of engineering throughout all the government universities in South Africa (excluding UNISA), only 21% (first year enrolment 2011) of engineering students attained their degrees in the allocated 4 years which has dropped from 23% (first year enrolment 2010) (Council on Higher Education, 2012; Council on Higher Education, 2013). The accumulated percentage of students finishing within 6 years has also dropped and is 50% (first year 2011) versus 52% (first year 2010) (Council on Higher Education, 2012; Council on Higher Education, 2013).

Given the high demand for engineers, it is problematic that the 4-year throughput rate is 21% and the 6-year throughput rate is 50%. It is thus necessary to investigate this problem to understand the reasons why the 4-year throughput rate is decreasing.

1.1 Problem Statement

The factors that affect academic performance are widely researched in the attempt to mitigate failures and to maximise the number of graduating students in each cohort. The problem is that there is no concrete understanding of the factors that affect academic performance in engineering students in South Africa. Secondly, there seems to be little research on the factors affecting academic performance as seen from the students' perspective. The following research questions will seek to understand these perspectives.

1.2 Research Questions

This research aims to answer the following questions:

What factors could affect student performance in engineering studies in a South African university, from the students' perspective?

Do the factors outlined in the work of Fisher (2011) *align with what the students experience in the School of Electrical and Information Engineering?*

1.3 Research Objectives

The objective for this research is to identify selected factors that students perceive as affecting their academic performance through understanding their experiences of university. Fisher's work is used as a framework to investigate the factors that students consider to be affecting their academic performance. Fisher interviewed

university staff to investigate the issue. The factors that emerged from Fisher's work are:

- Students' reasons for choosing engineering;
- The gap between school and university and the changes that this brings in terms of adjustment to new environments;
- Students' backgrounds and current situations, including financial aid, accommodation and support systems.

Using Fisher's work as a framework, these factors will be explored in focus groups with students to gain their perspective. These factors will be explored from the perspective of students in the School of Electrical and Information Engineering at the University of the Witwatersrand. The aim of this work is to establish whether or not the factors, as mentioned in Fisher's work resonates with the students, and to understand their perspective. Further, this research aims to uncover any unknown factors that affect students during their studies.

1.4 Dissertation Structure

Chapter 2 provides the problem context; the chapter begins with understanding the problem from a South African University context. Country-wide and school-level university data is then presented and explored to give a broader understanding of the problem at hand and to provide a rationale for the research. Chapter 3 explores literature on the factors that affect academic performance, including reasons for choosing engineering as a degree, the students' background and their support

structures. Chapter 4 explores the methods and methodological approaches that this research will use namely: focus groups, surveys and thematic analysis.

The survey results are presented in Chapter 5, and the focus group results, using thematic analysis along with research limitations are explored and discussed in Chapter 6. The themes that were found within the focus group space are student reasons for choosing engineering, student adjustment to university and student support structures. Emotional stress emerges as a major concern from the focus group analysis. Chapter 7 presents possible future work on the research, along with the conclusions to the dissertation.

1.5 Conclusion

This chapter includes an introduction to the background and the context of this problem. It is evident that the problem of throughput in Engineering affects society at large, as well as impacting the students directly. This research aims to investigate possible factors that influence the success of Engineering students, through understanding the student perspective.

Chapter 2

Contextualising Academic Performance in South Africa

This chapter introduces the problem and rationale, using government throughput data as well as school-level data from the School of Electrical and Information Engineering (EIE) at the University of the Witwatersrand, Johannesburg (Wits), to demonstrate that the throughput of engineering students is an issue that should be investigated.

2.1 Engineering Education Background

2.1.1 Engineering as a Critical Skill

According to global sources there is a worldwide shortage of engineers in industry (The Government of the Republic of South Africa, 2002; Radu, 2018; Engineering UK, 2018). In South Africa, the National Research and Development Strategy (NRDS) identifies the need for further developing the country (The Government of the Republic of South Africa, 2002). The South African government (The Government of the Republic of South Africa, 2002) details the need for research and development in specific sectors. In Science, Engineering and Technology (SET) the goal is to increase the throughput rate, i.e. increase the number of SET graduates completing their degrees in the minimum possible time (The Government of the Republic of South Africa, 2002).

The matter of low throughput rates in engineering degrees has been widely documented and is well recognised, however, local government does not seem to have published an acceptable target throughput rate for engineering students. The Department of Higher Education and Training (DHET) (Department of Higher Education and Training, 2014) released a draft report listing the top 100 most scarce skill occupations in South Africa and electrical engineering is number 1 on the list. The list contains 11 engineering jobs ranked as the top 20 most scarce occupations.

The demand for engineers in the workplace is evident. It is important to explore the reason why engineering students are not graduating in the minimum time, so that the throughput rate, and hence the number of engineers in the country, can be improved (Fisher, 2011; Department of Higher Education and Training, 2014).

2.1.2 Bachelor of Science in Engineering in South Africa

In South Africa, the Bachelor of Science in Engineering degree (BSc Eng.) is a professional degree which includes an Honours year. The minimum duration of the degree is 4 years. Entrance requirements at universities in South Africa vary and this research will focus on Wits University, and in particular to the School of EIE.

At Wits (University of the Witwatersrand, 2018), the minimum entrance requirement for Engineering is 60-69% for:

- English First Language or First Additional Language
- Mathematics
- Physical Science

Since there is a large number of applicants for a limited number of places in engineering degrees, Wits selects students who achieved at least 70% in these three subjects.

The students enrolling into Electrical Engineering at Wits are achieving higher marks than the stipulated minimum requirement to be considered (University of the Witwatersrand, 2018). Thus, setting aside any problems with the current schooling system and whether matric is adequately preparing students for university, it is assumed the majority of students enrolled achieved Matriculation marks above 70% in Mathematics, Physical Science and English. This implies that the students enrolled are among the top achievers in the country (University of the Witwatersrand, 2018). Yet despite this, the throughput rate of engineering graduates remains low, which indicates that there are factors other than Matriculation achievements affecting the throughput rate. Since improving the schooling system is an enormous project on its own, it is the responsibility of the students and university educators to find ways in which they can help and work together in order to ensure that they are able to succeed in the minimum required time.

2.2 South African Graduation Rate Statistics

Throughput rate is defined in this research as successfully completing each year and obtaining the degree in the minimum specified time of 4 years. This term is sometimes also referred to as “Graduation Rate” in literature.

Each year the Council on Higher Education (CHE) compiles and publishes reports on cohort statistics within South Africa. It is important to analyse these results, since many stakeholders say that engineering studies have low throughput rates that need to improve, to enhance the economy through addressing the engineering-skills scarcity in the country.

2.2.1 4-Year Engineering Degrees

The CHE documents specify throughput rates for 4-year Engineering degrees. Table 1 shows the percentage of engineers completing their degrees in 4-6 years, at government universities in South Africa (excluding UNISA) (Council on Higher Education, 2012; Council on Higher Education, 2013; Council on Higher Education, 2014; Council on Higher Education, 2015; Council on Higher Education, 2016; Council on Higher Education, 2017; Council on Higher Education, 2018). Table 1 shows the first year of enrolment in the Engineering degree, along with the total percentage of students that graduate within 4 years (allocated completion time (n years)), 5 years (n+1 years) and 6 years (n+2 years). The total number of graduates shows the overall percentage graduated after the 6 years, the total percentage of the cohort that dropped out of the degree, and finally the percentage of the cohort that is still in the system after 6 years.

Table 1: The percentage of Engineering graduates after 4, 5 and 6 years after initial enrolment from government universities throughout South Africa (excluding UNISA).

Year of Enrolment	Graduated in 4 years (%)	Graduated in 5 years (%)	Graduated in 6 years (%)	Total Graduates after 6 years (%)	Total Dropped out (%)	Still in system after 6 years (%)
2006	23	18	7	48	16	36
2007	22.2	19	10.2	51.4	13.6	35
2008	23	17	11	51	14	35
2009	23	17	11	51	14	35
2010	23	18	11	52	14	34
2011	21	19	10	50	15	35

Table 1 shows that the country's four-year throughput rate is low. However, the percentage of graduates completing their studies in 5 and 6 years significantly increases the total number of graduates in these programmes. The 4-year throughput rate decreased from the 2010 cohort to the 2011 cohort, and the number of students that have dropped out in these two cohorts is increasing. The total number of graduates after 6 years, which is the cumulative number of graduates completing the degree in 4, 5 and 6 years, shows that of all the registered students, on average only 51% of students are completing an engineering degree. This means that on average 49% of students are either taking longer than 6 years to complete their degree or have dropped out of the degree. The fact that the system is not retaining the drop-out students, and that the students are taking longer than the required completion time, makes it necessary to understand the reason for the throughput rate being so low.

The focus of this research is to understand what students see as the reasons that prevent them from completing the degree in the allocated time. The allocated time

for an Engineering degree is 4 years, so the low number of students completing their degrees in 4 years is a cause for concern.

2.2.2 School of Electrical and Information Engineering Statistics

The School of EIE publishes throughput rates every 5 years, and these results can be seen in Table 2 (School of Electrical & Information Engineering, 2017). These results are much lower than the CHE results, and the percentage of students completing their degrees in 4 years is lower than National results. The lower value could be as a result of the CHE statistics grouping engineering as a whole, which includes all the branches of engineering from all universities in South Africa where each university's total credits, and course-loads are not the same. It is important to note that the number of credits per degree differ not only between different branches of engineering, but also across universities, and credits relate directly to the course load experienced by students (Fisher, 2011). Table 2 shows that the number of students graduating in 4 years was 11.5% for the 2010 cohort and 10.2% for the 2011 cohort. The average number of students that dropped out of the School of EIE at Wits, in the 2009, 2010 and 2011 cohorts is 59%, which is significantly higher than the drop out percentage found in the CHE results. This shows that even though at a national level, it may seem that there are not enough graduates, there are individual schools that are worse off in terms of throughput compared to the government results.

These results are an overview of the throughput and drop-out rates from the School of EIE, which further show that research is needed if the school is to improve their throughput rate to match the government rate.

Table 2: The percentage of Engineering graduates after 4, 5 and 6 years after initial enrolment from the School of EIE at University of the Witwatersrand.

Year of Enrolment	Graduated in 4 years (%)	Graduated in 5 years (%)	Graduated in 6 years (%)	Total Graduates after 6 years (%)	Total Dropped out (%)	Still in system after 6 years (%)
2009	6.1	8.1	8.1	22.3	68	9.7
2010	11.5	10.7	8	30.2	57.7	12.1
2011	10.2	13.5	12.8	36.5	51.2	12.3

The overall throughput results from a national and a school level have been presented above, and it is shown that research will need to be conducted to understand the reasons for these low throughput results. The overall results do not provide enough insight into the problem however, as the core to this problem must be further investigated to understand the cohort demographics. The School of EIE student cohorts will be reviewed in the following section to provide further rationale for this research.

2.3 Three Cohorts in the School of Electrical and Information Engineering

A preliminary analysis was performed, in the School of EIE to determine the demographics of the 2014, 2015 and 2016 cohort, to better understand how the cohorts are comprised in terms of students and their marks. The demographics presented in Figure 1, Figure 2, Figure 3 and Figure 4 below show the distribution of marks in Matric for the first year of enrolment of the first year classes of 2014, 2015 and 2016.

Figure 1 and Figure 2 show the mark distribution of students for English as a home language and as a 1st additional language or a 2nd language respectively. From the analysis, it shows that the percentage of students in the respective first year classes that have come from a school where English was not a first language is approximately:

- 2014 = 48%
- 2015 = 58%
- 2016= 60%

This shows that in the first-year class starting in 2015 and 2016, more than half the class is learning at an English medium institution the first time. This could be a factor that affects academic performance and will be explored further within this research.

Figure 1 and Figure 2 show the mark distributions of students for English. In Figure 1, the majority of the class's marks fall in the 70-89 % range, whereas in Figure 2, the majority of students in 2015-2016 lie in the 60-79 % range, suggesting that the students who took English home language are students that are stronger in English compared to those that have learnt at a second language level.

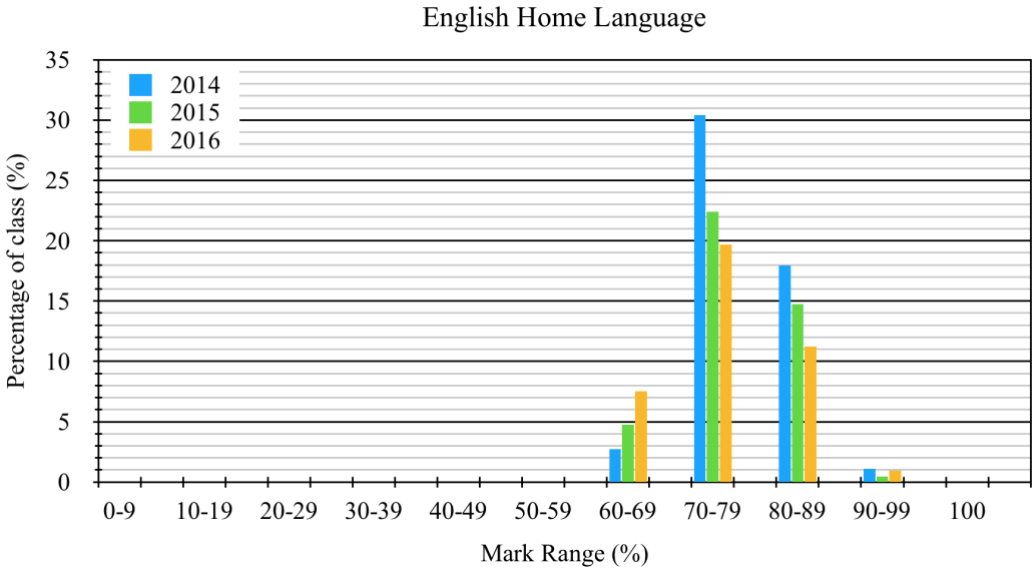


Figure 1: The distribution of Matric marks for Home language English.

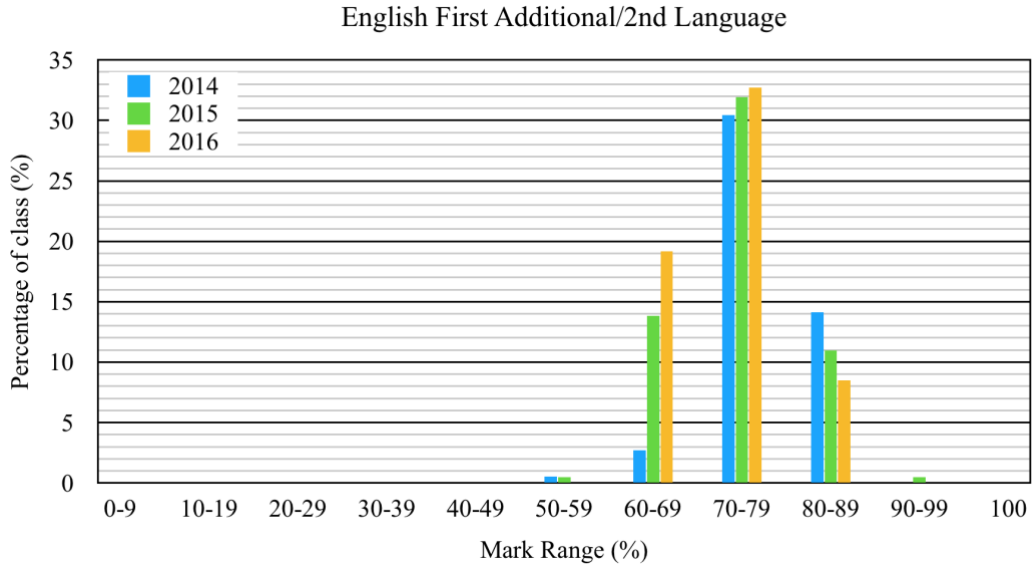


Figure 2: The distribution of Matric marks for First Additional/2nd language English.

In Figure 3 and Figure 4 the majority of students lie in the 70-99% ranges, which suggests that students enrolled in 1st year for the years 2014-2016 were strong in Mathematics and Physical Science. These results show that the majority of the

students entering first year Electrical and Information engineering are academically strong students.

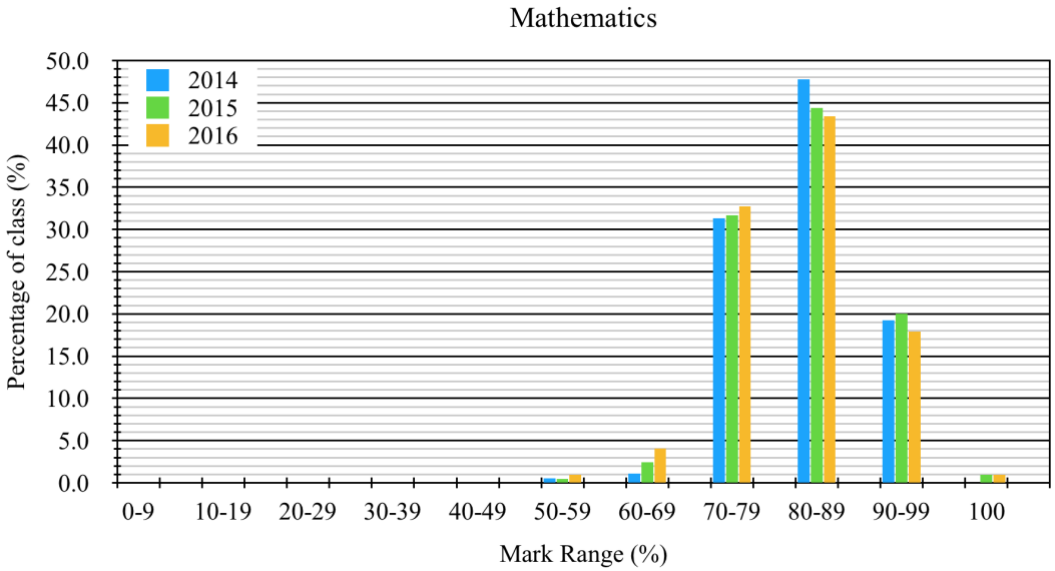


Figure 3: The distribution of Matric marks for Mathematics.

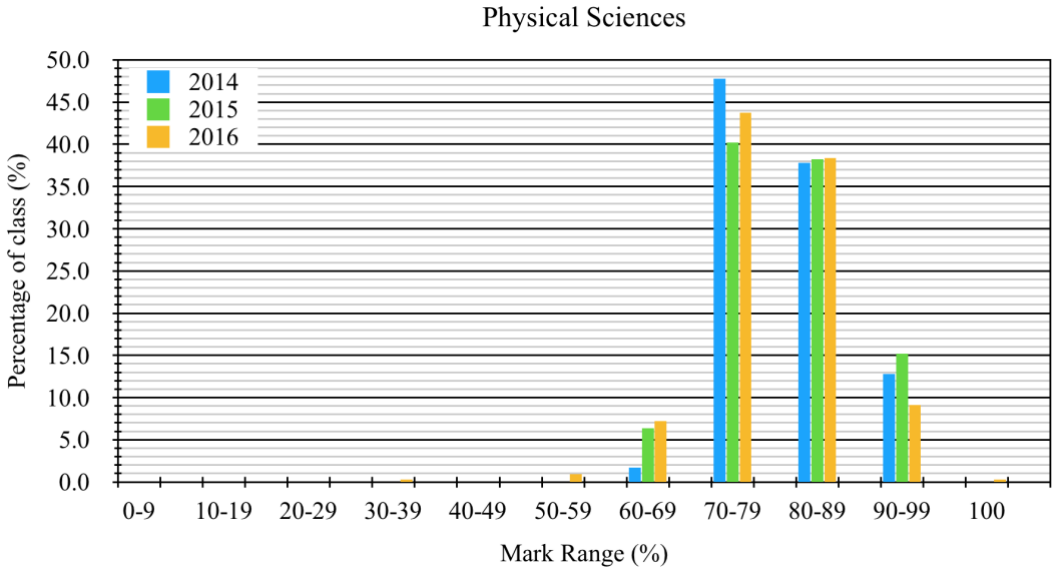


Figure 4: Showing the distribution of Matric marks for Physical Sciences.

In the above figures, the majority of the results are in the ranges of 70% and higher, which shows that students enrolled in Engineering are high achievers in high school.

2.4 Conclusion

In this chapter, the government throughput rates and the School of EIE throughput rates were presented. The School of EIE throughput rates are lower than the government results. It was also shown that the students are academically strong in high school, so this can be excluded as a reason contributing to poor throughput in university. Since the throughput rates are so low, and the drop-out rates are high, it is important to explore the possible reasons affecting these rates, so as to mitigate the low throughput rate and to minimise the drop-out rate in engineering.

Chapter 3

Factors Affecting Academic Performance in University

To populate a meaningful list of factors that are pertinent to student success, it is important to first review what others in the field have researched. Firstly, the research framework will be presented, followed by a comprehensive literature review, to contextualise the overall list of chosen factors for this study.

The chapter will then introduce the problem more specifically, through understanding the studies that have been done on an international level and local level. The fact that the pass rate is as low as it is, shows that the problem has either yet to be completely solved or is not fully understood.

3.1 Research Framework

The study performed by Glen Fisher, is a report that was for the Engineering Council of South Africa (ECSA). ECSA required a framework to assist with improving throughputs in Engineering, to help combat the shortage of Engineers in the country. The problem of throughput in South Africa, and how to increase throughput in engineering degrees, has been comprehensively researched by Glen Fisher (Fisher, 2011). Fisher's aims were to identify key issues affecting the throughput, as well as providing possible measures that can be put in place in an

attempt to improve the throughput rate, using data collected from academic staff from South African universities.

Fisher (2011) made use of both quantitative and qualitative data. The quantitative part of the study included enrolment statistics, throughput rates of various professional degrees, average completion rates of engineering across specific universities in South Africa as well as average performance rates at selected universities in South Africa. The qualitative part of the study included interviews with Academics at Universities within South Africa and Industry engineers. The Industry portion of Fisher's work will not be included as it does not form part of the scope of this research, as it is more focused on the industry's perspective of engineering graduates, and how engineering education can be improved, rather than focusing on the students' experiences and challenges throughout university. The question themes that were used as guidelines for the interviews with Academics are as follows taken from (Fisher, 2011):

- Reasons for students choosing engineering at the university as well as the specific branch of engineering
- Challenges students face in the degree
- Factors affecting student success
- Change in the student intake (over the years and in the future)
- University response to change in student intake
- Throughput rate and how it compares to other faculties and departments
- Throughput rate improvement within the existing curriculum/extended curriculum

The limitations of the study were that no students were interviewed as there was a time constraint. There have not been many qualitative studies performed where the students are the participants, which suggests that there is a gap in the field in South Africa. The problem trying to be solved is centred around the students' experiences, so it is important to include them in the studies to ensure that their perspective is gained on the problem.

The outcomes of Fisher's (2011) study revealed seven areas of change that could assist with increasing the throughput in Engineering. The seven areas are (taken directly from (Fisher, 2011):

1. *"Improving the talent pipeline from schools*
2. *Improved student selection*
3. *Coherent, integrated and timely student support*
4. *A flexible curriculum, with appropriate foundational support*
5. *Improved teaching and learning*
6. *Staffing*
7. *Funding"*

The first point includes the themes of under-preparedness, the gap between school and university. The second point includes students' reasons for choosing engineering and entrance requirements for the degree. The third point involves understanding the gap that students face between school and university, understanding their backgrounds, how they navigate the campus environment and their support structure and how accommodation, financial aid and language play a role in students' academic life at university. The fourth point discusses curriculum

and academic support in detail. The idea of curriculum design is a field on its own, and does not fall within the scope of this research, but academic support and a discussion on course load will be included, as they are part of the scope of this work. The fifth point discusses the nature of teaching in a higher education environment, the "killer courses", the need developing the Academics at universities, improving and academic support through the use of online tools. The sixth point discusses staffing statistics at universities, discussion of the challenges that universities have in retaining staff, and understanding the challenges academics face with the increasing student intake. This point does not form part of the scope of this work and will thus be omitted, as this research focuses on the students' experiences and factors affecting performance. The final point discusses funding with respect to state subsidies in education, student financial aid and industry financial contribution.

As introduced in Chapter 1, Fisher's work will be used as a framework for this study. The work performed by Fisher had the approach of viewing the problem from the academics' perspective and their understanding of factors affecting performance in engineering, where one of his limitations as stated in his work was that he was unable to interview students. The approach that students' perspectives could contribute to an understanding of this problem is important.

The above points will be discussed in further detail within this chapter however, it will be used as a framework for this study. Fisher (2011) will be used to understand the research problem from the students' perspective. Fisher (2011) will be used to

triangulate and to further understand the research analysis. If the analysis shows significant similarity with Fisher (2011), then this research will be considered valid.

3.2 Reasons for Pursuing Engineering

Some of the deciding factors in students wanting to pursue engineering are discussed by Fisher (2011) these include bursary and job opportunities as well as wanting to "make a difference, to create and fix things" (Fisher, 2011, p. 43). The main point made is that many students are not well-informed about the constituent parts of engineering and the discipline as a whole. As a result, these students either drop out of engineering or may be at risk of failing if they persevere, since engineering is not their desired field (Fisher, 2011). This is an interesting topic raised by Fisher, and since the reasons for pursuing engineering seem to have an effect on student performance, these will be explored further in this study to understand whether or not students also perceive this as a factor affecting their academic performance.

Several authors found that having an interest in Mathematics and Science, in addition to getting good grades for these subjects at school, can influence a student's success in engineering and whether they will stay in engineering, or will move to another program (French, Immekus, & Oakes, 2005; Besterfield-Sacre, Atman, & Shuman, 1997; Geisinger & Raman, 2013). An American-based study at the University of Pittsburgh concludes that success in engineering programmes does not solely depend on the students' intellect but requires a good attitude, as well as a strong interest in mathematics, science and engineering (Besterfield-Sacre,

Atman, & Shuman, 1997). The paper concludes that students who dropped out of engineering had a lower interest in Mathematics and Science (Besterfield-Sacre, Atman, & Shuman, 1997).

Kokkelenberg & Sinha (2010) performed a quantitative study at Binghamton University to identify factors affecting academic success. This paper found that there were several factors that could affect academic success; namely strong mathematical ability and prior preparation for engineering, and interest in the field from before university (Kokkelenberg & Sinha, 2010). According to Kokkelenberg & Sinha (2010), interest is based on the students taking STEM courses in high school. This paper also mentions that interest for the degree may come from school exhibitions such as science fairs or it might come from scientific based toys or even from a family member. This shows that success of a student in engineering could come from the reason for choosing the degree or even prior engagement with the engineering industry. The results from this study also agree with Fisher (2011) and with Painter, Snyder & Ralston (2017).

According to Painter et al. (2017), it is the student's self-efficacy and personal goals that help them in choosing a degree. Painter et al. state that students who want to study in a STEM field should be significantly competent in Mathematics (Painter, Snyder, & Ralston, 2017). This paper also states that an interest in the subject matter is important when choosing an engineering degree. The study used a survey to ask the students for their reasons for choosing engineering, where the students could write an answer instead of choosing from a set list, which limits the bias of

the study. The outcome of the study performed by Painter et al. (2017) showed that the most common reasons for choosing engineering are as follows:

- Subject interest
- Family influence
- Experience in the field

Other factors like career outlook, social influences and subject excellence were mentioned, but appeared less frequently.

Cruz & Kellam (2018) discuss that students at an American university have various reasons for choosing engineering. The research makes use of interviews and thematic coding and analysis, with a sample size of 21 students. It concludes that students' reasons for choosing engineering can contribute to student retention. Reasons that will assist retention according to the research by Cruz & Kellam are similar to those of (Besterfield-Sacre, Atman, & Shuman, 1997; Fisher, 2011; French, Immekus, & Oakes, 2005; Geisinger & Raman, 2013; Kokkelenberg & Sinha, 2010; Painter, Snyder, & Ralston, 2017).

The idea of an interest in the subject matter that a student will be studying has appeared in several of the papers reviewed, and thus seems to be a common factor which affects success in engineering. The work by the researchers is mainly quantitative research, this suggests that further work needs to be done in the qualitative space to understand students' reasons for choosing the degree. Interest as a factor affecting academic success can be compared using these studies as validation.

3.3 Student Background

Other factors recorded by Fisher that are related to throughput include students' circumstantial family backgrounds including native language (Fisher, 2011). Some factors relating to student background and family history include facing the challenges of either travelling long distances to university each day or moving from rural to urban areas to study at university. As a result of the changes from school to university, students are overwhelmed and excited by the new university environment and some struggle to prioritise their academics over playing sports or socialising, which could result in failure of courses (Fisher, 2011). Students come from a range of family histories including those from poverty-stricken backgrounds where the students might be the first in their family to attend university.

A survey performed by the Academic Development Unit (ADU) at Wits (Academic Development Unit, University of the Witwatersrand, 2018), showed that in the Faculty of Engineering and the Built Environment (FEBE) within the first-year class in 2018, 62% of students take 15 minutes to travel (one-way) to university. What is more important, however, is that 38% of students are travelling more than 30 minutes (one-way) to get to university and 15% of students travel (one-way) 90 minutes or more to get to university. The fact that students are spending significant amounts of time travelling to university, could impact the amount of time these students have to study when they get home. This could be a significant factor that affects academic performance as with any university degree, it requires substantial time to study. If the students are travelling far distances everyday this

could be an added stress, the factor will be investigated in this study, as a possible factor affecting student performance.

Another survey performed in 2018 by the ADU at Wits (Academic Development Unit, University of the Witwatersrand, 2018), showed that in the FEBE first-year class, 41% of students are the first generation in their families to go to university. In the School of EIE, 51% of students were the first in their families to go to university. This shows that almost half of the students in first year are facing challenges that their families have never had to deal with. Fisher (2011) discusses that students who are the first in their families to attend university might find it might find it difficult to familiarise themselves to the new environment. This could further pose problems where families might not be able to understand the stresses of university and the workload involved, which could be a source of stress for the student. This survey also showed that approximately 16% of the first-year students in FEBE struggle with access to food. This is especially notable as these students are facing the stress of studying a degree and could possibly go without food on some days (Academic Development Unit, University of the Witwatersrand, 2018). The ADU runs a food program for these students whereby they are given a meal at the university every day, which assists them with access to food.

The issue of language is briefly discussed by Fisher, and it is mentioned that students that are not 1st language English speakers are hindered by this in an English-medium university (Fisher, 2011). These students battle to understand the complex level of English spoken by some lecturers; and learning becomes an even

bigger challenge when the lecturer is not a 1st language English speaker (Fisher, 2011).

Exploring the current students' first-hand experience of the environment change, as well as investigating the time spent doing other activities could provide useful information to identify where some students are falling short with time-management.

A South African based study at the University of Johannesburg (UJ) proposes that being digitally literate is a contributing factor to a student's success in an Information Technology (IT) course (van der Westhuizen & Barlow-Jones, 2011). This study uses surveys and a focus group with attention to the students' background in terms of (van der Westhuizen & Barlow-Jones, 2011):

- Where they previously lived (urban/rural)
- Previous access to computer technology (internet/computer/mobile phone)
- Home language
- Matric English result
- Access to a computer at home
- Level of ability to use a computer
- Type of area previously lived in during school years (urban or rural)

Through the use of basic data analysis techniques and the use of the ‘t’ test and Mann-Whitney U test, the conclusion is that students who fall into the below categories did better in the IT course (van der Westhuizen & Barlow-Jones, 2011):

- Lived in urban areas
- Good results in Matriculation English
- Had previous access to and are skilled in using a computer

The UJ focus group had a small sample of only 7 students. The reason for the sample size is not detailed. However, the sample seems to be purposive, as it only included students that had already failed a module and had no access to computer technology prior to university.

The focus group developed several themes from interactions with the students, and the main issues raised by students were that they found the course challenging due to the following factors (van der Westhuizen & Barlow-Jones, 2011):

- Lack of funding for university as well as for the course textbook
- Lack of time available for working (after travelling home after university)
- Lack of emotional support from home

In conclusion, it is observed that a deficiency in computer literacy and access to technology are only a few factors among several others that hinder a student’s academic success in an IT course. The key idea that is to be taken away from this paper is that factors relating to socio-economic background and personal factors should be analysed together with academic achievement to obtain a more thorough understanding of the student.

The UJ study assists in understanding the background of university students in South Africa and gives more insight into the types of factors that affect academic performance. Student language has been shown to be a factor affecting academic performance. It seems that students who are first language English seem to perform better academically. Language as a factor affecting academic performance will be explored, since as shown in Chapter 2, there are increasing numbers of students entering engineering with second language English. Since students with first language English perform better, it might mean that with the increasing number of students not speaking English as a first language, the academic performance of students could be affected negatively.

3.4 Gap between School and University

The gap between school and university is a factor that affects the success and retention of students. The gap suggests that students who enter university are not fully prepared for the journey. Preparedness could be categorised in terms of academic ability, as well as academic maturity. A learner may have the learning ability, but the question is whether they have the required maturity to cope with the vast amount of diverse knowledge they will face in their degree, as well as the ability to adapt from a caring school environment into an environment which is largely based on the individual responsibility for completing one's own work (Nel, Troskie-de Bruin, & Bitzer, 2009).

Case, Marshall & Grayson (2013) discuss that students' performance could be related to their level of preparedness when they enter university. Academic

preparedness is defined here as being academically competent for the requirements of university. The fact that students are achieving good results in matric but are not performing in first year shows that the students are not academically prepared for first year (Case, Marshall, & Grayson, 2013). Case et al. (2013) also suggest that to assist students, it is important to allow the students to learn in a space which is interactive and facilitates group interaction through learning. Fisher (2011) suggests that the under-preparedness could be as a result of the problems in the schooling system, which is in line with Case et al. Fisher (2011) states that the gap between school and university is experienced by all students, this is because there are challenges navigating the different expectations, while also managing independence and the vastly different environment at university.

Nel, Troskie-de Bruin & Bitzer (2009) discusses the effect of the gap from school to university and how this is affecting the success of students in first year. Nel et al. (2009) suggest that it is the fault of both schools and universities that are causing the low success rate of first year students, since schools are not preparing students well and that universities are not prepared enough for these learners when they enter university. According to Nel et al. (2009), for a better success rate, universities should be working with schools to ensure that students are better prepared, by having explicit entry requirements.

Nel et al. (2009) make use of both qualitative and quantitative methods. The experiments include a questionnaire to students applying to the university, as well as interviews of students who enter this university in first year. One of the significant findings in the study are that the schooling background affects the

student when moving from school to university, and that the level of understanding in Mathematics, science and computers correlate with the background of the student (Nel, Troskie-de Bruin, & Bitzer, 2009).

Furthermore, to combat this gap between school and university, a framework is proposed for schools and universities to liaise to make the transition smoother and easier for students (Nel, Troskie-de Bruin, & Bitzer, 2009). The main factors that are discussed in the framework are as follows:

- Academic
- Social
- Financial
- Expectations
- Cultural

This framework assists in enabling schools and universities to interact and assist students in making the gap from school to university smaller. It is understood that the gap from school to university can affect student performance. However, this study will not be looking for ways in which to fix the gap between university and school, but rather to see if students perceive that this gap to be affecting their academic performance.

3.5 Financial Aid

Fisher (2011) also discusses the effect of having (or not having) financial aid. Some students, especially those that are from disadvantaged backgrounds, depend highly

on bursaries for attending university. This is important since a student who depends on a bursary is at risk of losing funding if they fail, leaving the student in debt and unable to complete their degrees (Fisher, 2011). One concern is that financial aid is not paid at the start of the academic year, which results in students not having the relevant resources to study, and in some cases not having funds to pay for personal expenses and basic needs, which hinders the learning process (Fisher, 2011). Such a concern can be addressed through improved processes by companies that grant financial aid. This concern will be addressed later in this study, since lack of finances seems to be a fundamental factor in South African universities. There are benefits to having a bursary as well, for example some companies provide the opportunity to gain work experience and insight into the field of engineering. This could help the student discover which branch and industry is of interest to them, as well as providing a practical and theoretical set of skills that can go hand-in-hand with the curriculum of the degree.

3.6 Support Structure

Another factor that has an effect on student success is the access to or lack of accommodation. Fisher (2011) concludes that student accommodation not only provides the basic needs to the student, but also facilitates a better environment to learn and study in, and assists students to adapt to university life.

Students that do not live in student accommodation, but live at home or in an apartment, may lack the required support at home as well not having access to certain facilities such as libraries or computers. Fortunately, for those living in

university residences, there is some academic support provided, and access to some facilities, such as being in close proximity to libraries and having internet access (Fisher, 2011; University of the Witwatersrand, 2017). Fisher (2011) discusses that students that live in student accommodation form groups and study together which helps with motivation, and it is noted that students who do not live in student accommodation may not have anyone to study with when they go home. In addition to understanding the experiences of those who do live in student accommodation, it would be informative to understand the experiences (with regards to studying) of students who do not live in student accommodation.

Trengove (2017) discusses the idea of feedback in university learning, in the context of an engineering course. A learning activity that was performed as part of Trengove's study was that in a "test-like" setting, the students would be given a problem that needed to be solved, they would then have time to solve the problem on their own. After some time, the students would get into groups of between five and six students and solve the problem together. The feedback from the students showed that they enjoyed learning from their peers and working in groups to solve the problems after working on the problem individually. Some students mentioned that it was easier to ask for assistance from a peer rather than a lecturer. The conclusions show that very few students did not enjoy the learning activity. The idea of working/studying with peers will be investigated to understand whether it assists students with their learning.

Academic support is discussed in the paper by Fisher (2011), and he concludes that it is needed in order to assist with improving the throughput rate.

By understanding students' learning methods and knowing their level of understanding in modules, lecturers can adapt and focus on aspects that are of concern to the students (Fisher, 2011).

Nel et al. (2009) and Fisher (2011) mention that support, whether social or family, is an important factor in the student's success in university adjustment. It is mentioned that students who are the first in their family to attend university struggle to get the support they need from their family as their parents do not understand their workload. This could be taxing on the student as their parents have high expectations of them, and do not understand the idea of failure. Nel et al. (2009) also discuss the importance of a social group at university as the students have the support of other students in the same position as them, and when it comes to stressful situations, they have a social group that understands their struggles.

Students' learning methods, the support of their peers and family, and the effect of academic support at university will be further investigated in this research study. Through investigating how students learn and by understanding their support structures, these factors will be better understood.

3.7 Academic Results as Factors for Success

The course load and degree credits in engineering differ between institutions, but the minimum number of credits required, is 560 for the Bachelor's degree in Engineering (Fisher, 2011). According to the Higher Education Qualifications Sub-Framework (HEQSF), every credit is equivalent to "10 notional study hours". This

includes time spent in lectures, tutorials, laboratories, studying, doing projects and preparing for tests and exams (Council on Higher Education, 2013).

French, Immekus & Oakes (2005) in an American-based study at Purdue University analyse several variables, including high school rank, gender and motivation. High-school rank is the student's academic standing prior to entering university. Motivation is determined with the use of the "Academic Motivation Scale" (AMS-C 28), developed by Vallerand et al. (Vallerand, et al., 1992-1993). AMS-C 28 is a 28-question survey using a 7-point scale, which is administered on university students to determine their academic motivation.

French et al. (2005) concludes that high school rank, and motivation are predictors for success and persistence. Family background is suggested to possibly have an impact on the student. According to French et al. (2005), for students to succeed in engineering they need to be motivated, while also being academically strong. This study will not cover the aspect of motivation, as this is a field in its own.

Another study, performed by Li, Rusk & Song (2013) at the University of Victoria in Canada uses the analysis of first-year academic data of Electrical and Computer Engineering. Its main aim was to determine factors for student attrition, through a purely quantitative analysis (Li, Rusk, & Song, 2013). The issue of attrition after first-year engineering is said to be approximately 30% worldwide. It was shown earlier in this report that South Africa faces a worse attrition after first-year engineering. Li et al. (2013) makes use of Principle Component Analysis (PCA), a statistical analysis, that concludes that the three first-year subjects that show

significant influence on a student performance are Calculus I, Matrix Algebra and Design and Communication II.

This conclusion strongly links to the conclusions made by Besterfield-Sacre, Atman & Shuman (1997), and to the fact that engineering is intensely reliant on mathematical skills and understanding.

3.8 Conclusion

This chapter provides an overview of the literature that informs the background and the context for this problem that was given in Chapter 1. It is evident that the problem of throughput in Engineering affects society at large and impacts students directly. This research aims to investigate possible factors that engineering students perceive as influencing their success.

Fisher's work in South Africa is important and relevant (Fisher, 2011). His work includes most universities in South Africa with the input from Heads of Schools and the Deans of Faculties. The input from these stakeholders is valuable as they interact with students on a day-to-day basis. However, it would be more useful to have input from the students that are currently enrolled in the degree itself. Having the students' perspective on their own experience through the degree would be valuable as the 3rd parties (Heads of Schools and Deans) might not know all the information. This study aims to complement the work done by Fisher in order to make a stronger argument for the factors that are affecting success in Engineering degrees in South Africa.

In a paper by Haggis (2009), it is mentioned that over the past 40 years, research in leading higher education journals has been conducted in a very similar way, namely to understand the way that the individual learns, focussing particularly on how to get students to engage in deep learning approaches. Haggis proposes that as researchers we should step away from the paradigm of how individual students learn, to look at how the environment affects our students instead. This study uses Fisher's work (Fisher, 2011) as a framework to examine student perceptions of factors in their environment that affect their success.

Existing research has not clearly identified issues that pertain to the students through direct conversation with the students themselves; it has used either quantitative methods or qualitative methods through the perspective of the academic staff. Little research explores the problem from the students' perspective. This research aims to explore the factors affecting academic performance through the lens of the student, using qualitative methods. The next chapter defines the methods and methodological approach that this research will follow.

Chapter 4

Research Methods and Methodology

Chapter 1, Chapter 2 and Chapter 3 introduced the problem, a critique of the literature, and the research question and objectives were identified and justified. This chapter will now introduce the entire problem as a system. Each sub-system is a method within the research. This chapter will thus discuss the system overview, the data methods including experiments and analysis and the relevant ethical considerations and researcher stance that are required for this research. The main research method that will be used is of a qualitative nature because to answer the research question and objectives, it is important to understand the student participants deeply to uncover any issues or factors that they think could affect their performance.

4.1 Ethical Considerations

The researcher worked with engineering students as participants for this study, hence ethics clearance, as well as permission from the Deputy Registrar and the Head of School was obtained before the commencement of any data collection.

Ethics clearance was required in order for the University to ensure that the study would not be harmful or invasive in any way and would not reveal any person's identity during the process of the research, or in any future publications of the research. The clearance ensures that topics and questions are well written and

unambiguous and furthermore that the participant understands the objectives and possible outcomes of the research and their rights as participants.

The ethics application was done through the Human Research Ethics Committee non-medical (HREC (non-medical)), to conduct questionnaires and focus groups. The ethics application included all the relevant participant information and participant consent forms. The ethics clearance protocol number is H17/05/16.

Attached in Appendix A are the relevant documents for:

- Letter of permission from the Deputy Registrar
- Letter of permission from the Head of School
- Ethics clearance certificate

Furthermore, it was necessary to understand the ethical procedures to be followed throughout the research. The researcher was required to explain the research to potential participants and explaining their rights to them. Each potential participant was told that their identity and information would be kept confidential and they were given the choice whether or not to participate. In each of the focus groups a similar process was followed, and each group was told that they would be recorded. It was emphasised that the recording would not be heard by anyone else but the researcher, and the participants were encouraged to answer based on their experiences, as the researcher was not looking for specific answers.

4.2 Methodology Overview

The overall research approach is represented in Figure 5. The research is based on both qualitative and quantitative research (Creswell & Plano Clark, 2011). Quantitative data was used to identify both potential participants and issues for the qualitative research, which is the emphasis of this study. The qualitative research, however, is the central focus for answering the research question.

Throughout this section, the system has been grouped into the various sub-systems that can be seen in Figure 5.

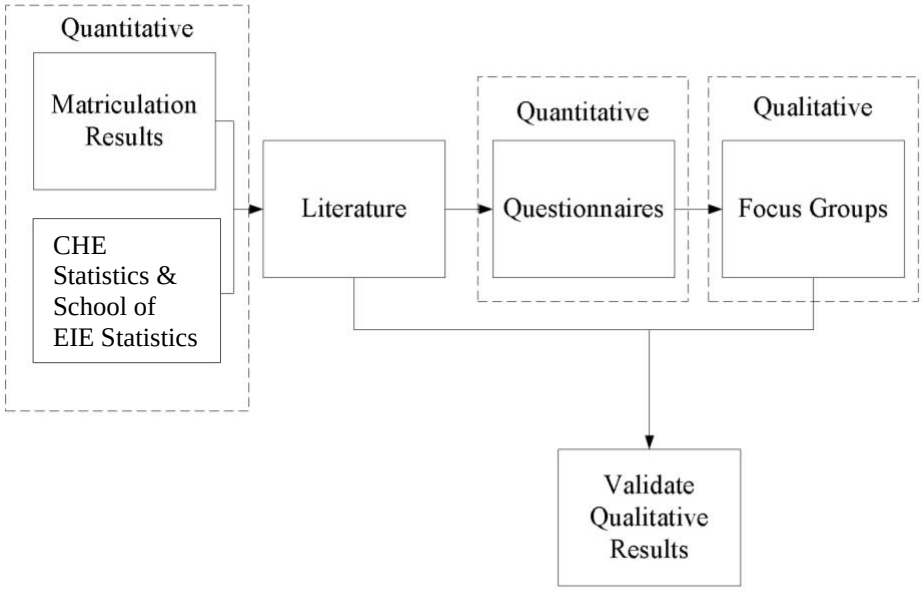


Figure 5: A flow diagram of the final research approach.

In previous Engineering education research, the main focus has been on quantitative research, in an attempt to understand the attrition rates and other performance factors through the use of marks and other features. Most research has drawn on quantitative research to increase throughput and understand the factors that affect throughput. Some research has made use of qualitative research. One such study

is that of Fisher (2011). Fisher interviewed Academics of some faculties, as well as industry members of engineering in South Africa. The outcomes of his research were described in Chapter 3, and is used as a framework for exploring this research from the students' perspective. This work is critical in answering the research questions, namely:

- What factors could affect student performance in Engineering at a South African University, from the students' perspective;
- Do the factors outlined in the work of Fisher (2011) align with what the students experience in the School of Electrical and Information Engineering?

The emphasis on this study will be qualitative work, but will include quantitative work to assist with sampling for the qualitative portion. To best understand students' perspectives on performance, qualitative research will yield rich data and obtain insights into students' experiences. Students' experiences could help academics to understand students and to help students through university.

4.2.1 Research Methods' Alignment with Research Purpose

The purpose of this research is to determine which factors students think are affecting their academic performance in Engineering. From the literature review in Chapter 2 and Chapter 3, it is evident that apart from academic results, there are other factors that affect a student's academic performance. These factors could include socio-economic background, personal interests, as well as skills that depend on the student's experiences through university.

Both qualitative and quantitative research can be beneficial in solving problems. Quantitative research allows the researcher to solve problems using mathematical solving techniques, and to solve problems using a strong analytical approach. In some cases, where a deeper understanding is required of the participants, qualitative research is used. Qualitative research allows the researcher to explore ideas with the participants through the process of an interview or through focus groups (Creswell & Plano Clark, 2011; Bryman, 2012).

This research cannot solely rely on quantitative methods, but requires the use of qualitative methods as well, to best understand the environment and become familiar with the perceptions and experiences of the students currently enrolled in the engineering program. This will give insight into the problems that students face, which will assist in understanding what kind of factors affect academic performance in engineering.

4.3 Researcher's Role in the Research

Since this research is taking a qualitative approach to answering the research questions, it is important to note that this type of research is generally subjective. The researcher cannot remove themselves from this type of research (Bryman, 2012). The researcher was aware of this through the qualitative process and attempted to be as unbiased as possible when conducting the focus groups, analysing them and during the write up. The researcher's past has influenced choosing this research and in doing so there will be pre-conceived ideas or conclusions. Since it will be the researcher doing the writing up and analysis, it

must be noted that the findings will be impacted to a certain extent by the researcher's past. This awareness makes it possible to try to limit any possible bias.

4.4 Mixed Methods: Explanatory Research

This study will make use of a mixed-methods explanatory research approach using the participant selection model (Creswell & Plano Clark, 2011). Explanatory research is a research design that uses both qualitative and quantitative data. This research will employ the approach of explanatory research that assists with participant selection (Creswell & Plano Clark, 2011). To perform purposive sampling to obtain an adequate sample for the focus groups, quantitative surveys will be employed to identify participants that fit the criteria for the focus groups. In this model, the qualitative portion of the research is the focus of this research and the quantitative portion assists with obtaining a valid and reliable sample for the qualitative portion.

The quantitative data from Chapter 2, leads to further exploration through the use of qualitative data, with the use of surveys to perform purposive sampling for the qualitative part. Qualitative data is used to obtain an in-depth understanding of students' views, through listening to the students' views and understanding their experiences as they live them. Qualitative research also provides the researcher with a rich data set which explain in experiences in detail. The factors from both the literature survey and the academic data presented in Chapter 2, were used to design the content of the focus groups. The sample of the focus groups was determined using purposive sampling, through the use of quantitative surveys and

analysis. The quantitative and qualitative sections will be discussed in the following sections.

4.5 Quantitative Sub-system

Quantitative methods have been used in two parts of this research. Some of the quantitative research was presented in Chapter 2, to form part of the justification of the research question and demonstrating the need for further exploration of the problem. The second part of the quantitative research was used in the qualitative sampling process in this research. The quantitative methods will be presented below.

4.5.1 Self-Completion Questionnaire

Questionnaires focus on questions that are predominantly short and closed in nature, to avoid lack of interest by the participant (Bryman, 2012). It is answered by the participants and is usually in the form of a paper questionnaire.

Questionnaires limit "interviewer bias", in that the researcher will have no effect on the answers of the participant and the participants all receive the questions in the same manner and order (Bryman, 2012). There are however some drawbacks to this method, for example, the researcher does not assist the participant and thus clarity on ambiguous questions could go unnoticed by the researcher (Bryman, 2012).

Some of the factors determined in the literature survey were further investigated through the questionnaire, which can be seen in Appendix B.

The list below outlines some of the factors that have been addressed through questions in the questionnaire, and expanded through the use of the focus groups:

- Whether the student has financial aid or not
- Whether the student lives in university residence or not
- If the student took first, first-additional or second language English as a subject at school

The questionnaires were administered on all 1st - 4th year engineering students in 2017, in all branches that fall under EIE, namely: Digital Arts, Biomedical Engineering and Electrical and Information students. The details of the survey sample are described in detail in section 5.1.

4.5.1.1 Questionnaire Process

The questionnaire had two purposes, namely:

- To gather data from all years of study to understand some of the factors that were explored in the literature;
- To populate the focus group sample using the questionnaire respondents that have given consent to participate in the focus group process.

The questions were based on common factors for success that appeared in the literature. The common factors were: Language medium at school, living distance from university and whether a student was in residence or not and whether a student has financial aid or not.

The researcher met with lecturers from each of the years of study to explain the research and to inform them of the need to attend one of their lecturers to administer the questionnaire.

The researcher first began by explaining the research to the students and informing them that it was not compulsory to take part in the study. For the second aim of the questionnaire, it was also important to explain the focus groups to the students (which will be discussed in the following section). The students were then given participant information forms for both the questionnaire and the focus groups, as well as a consent form for the questionnaire (as can be seen in Appendix B). The students were given the option to choose to participate in a focus group – which would happen later in the same semester. The focus group sample could then be purposively selected from the students that consented to take part in a focus group.

The questionnaire was then handed out to the students and if they chose to complete it, they were given approximately 10 minutes to fill it out and to place it in a box at the front of the venue.

4.5.1.2 Questionnaire Analysis Process

The questionnaires were then processed into a spreadsheet, allowing the researcher to link the student numbers to the answered information. From this step, the researcher was able to analyse the research sample in terms of the selected questions, and these results are presented in Chapter 5.

4.5.2 Archive Academic Data

Student's academic results were used in the literature survey to show the importance of the research question, and to give further insight into the research problem.

4.5.2.1 Sample

The sample for the academic data was chosen to be from the years 2014 to 2016. The sample was chosen for analysis as the schooling system changed, and comparisons should not be made where there were large changes in a system. It was also taken into account that the cohorts differ from each other, and it is important to be cognisant of not comparing too many cohorts as there could be a mismatch in results. It was decided to use the first-year cohorts of the years 2014, 2015, 2016 and 2017 when this research was started, as the focus groups would include all of these students from first to fourth year.

4.5.2.2 Academic Data Process and Analysis

The data was requested from the university after ethics was granted. The required data was provided in a softcopy format. The researcher was required to go through the data to ensure that there were no duplicates or inconsistencies with the data, regarding empty/null values.

A summary of the data was then made, to obtain average marks for all the students and then further creating overall graphs of all the required features.

4.6 Qualitative Sub-System

The qualitative sub-system was the main focus of the research. The method that was used was focus groups. Focus groups are discussions that usually concentrate on a selected number of issues, while the researcher listens and pays attention to the way in which the discussion takes place, specifically the tone and direction that the focus group follows (Bryman, 2012). Focus groups were used in order to gain a deep understanding of the participants' experiences. The main advantage of the focus groups was to be able to ask further questions for clarification, and to see the participants' interaction with each other. The focus groups provided a rich data set to work with, as the students not only engaged with the researcher, but also engaged through discussion and asked each other questions.

The researcher's discussion questions for the focus groups revolved around the literature. The focus groups were conducted and analysed by the researcher, and no analysis software was used in the process. It was an advantage to be able to process and transcribe the recordings, as the researcher was able to engage thoroughly with the data. The expressions and the manner in which the participants answered gave a clear understanding when interpreting and analysing the data (Braun & Clarke, 2006).

The focus group process can be seen in Figure 6 below. The sub-systems comprise the research population, which is all the participants that agreed to participate in the focus groups when completing the initial survey. The focus groups were grouped based on specific criteria, as will be discussed below. The focus groups were then

conducted, and the analysis was performed. The analysis technique is Thematic Analysis and will be discussed below.

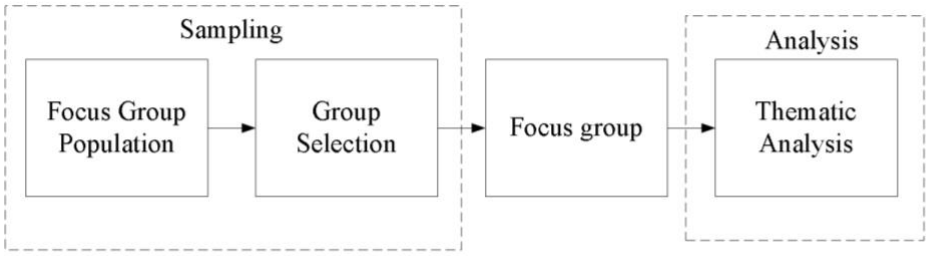


Figure 6: The focus group process.

4.6.1 Research Population

The population sample for the focus groups was determined using the guideline outlined by Cohen, Manion & Morrison (2000). The population size of this research was determined by the number of students in the school of EIE in 2017. This would be the sample that would be used to determine the focus group participants.

The overall population of the school of EIE in 2017 was 917 students. From this population, a survey (the self-completion survey mentioned in the above section) was used in order to choose the focus group participants.

The survey included questions relating to the following topics, and the survey can be seen in Appendix B:

- Language medium at school
- Financial aid status
- University/off campus accommodation
- Willing to participate in the focus group stage

The survey was conducted on all years of study and it was optional to participate. The number of responses from the survey was 411. This means that approximately 45% of the students participated. From this 45% approximately 86% were willing to participate in the focus group stage of the research. The sampling for the focus groups was then performed using the 353 participants that were willing to take part in the focus groups and will be discussed in the next sub-section. The focus group population can be seen below in Figure 7.

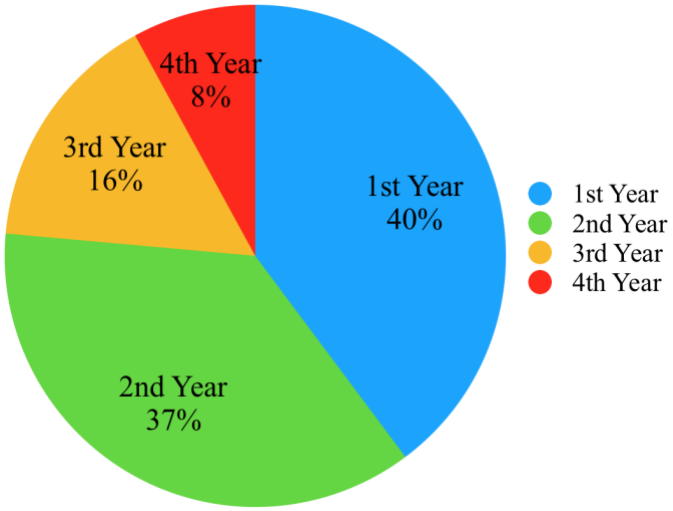


Figure 7: The research population for the focus groups.

4.6.2 Focus Group Sample

The focus group sample was then chosen from the new population size of 353 participants. The type of sampling that was used in determining the focus groups is purposive sampling (Cohen, Manion, & Morrison, 2000). Purposive sampling selects the sample based on specific characteristics; in this case the characteristics were based on the survey that was completed by the participants. This type of sampling was used to ensure that the focus group environment was a comfortable space for the students, meaning that students would not feel embarrassed talking in front of their peers, and in some circumstances the students would be able to relate to their peers and be able to discuss amongst each other (Bryman, 2012; Morgan D. , 1997). The concept of choosing participants who are not strangers has been seen as favourable in focus groups as it assists with the group feeling comfortable to talk about the topics (Bryman, 2012; Morgan D. , 1997). The research already focuses on one school in the engineering department, and this too contributed to the students feeling more comfortable in the setting, as they were amongst EIE peers, and are studying the same or a similar programme to one another.

The focus group participants were grouped according to specific criteria namely:

- Language medium at school
- Financial aid status
- University/off campus accommodation

The issues that were raised were in the context of whether these issues influence their academic success. The focus group questions were related to grouping criterion as well as the following topics:

- How do you study?
- Access to computer and internet facilities (prior to university and currently)
- Support structure
- Reason for choosing the degree
- Academic support
- Hours spent studying, socialising and doing other activities

The full list of themes and questions explored in the focus groups can be seen in Appendix C.

In order to obtain meaningful results, 5 focus groups were conducted. To ensure that themes are not specific to one group, the focus groups aimed to group students from similar walks of life as follows:

- First language English in school
- First language not English
- Has financial aid
- Does not have financial aid
- Lives on campus in university residence
- Lives off campus

One group combined students that had financial aid, another group combined students who did not have financial aid and a third group combined students who lived off campus. The other 2 groups were diverse students from all the groups. Each focus group contained approximately 5-9 participants. Since the participants were exclusively from the school of EIE, it was likely that they would either have interacted with the other participants and/or have some form of familiarity and comfort in the environment to discuss matters influencing their success. The overall sample of focus group attendees can be seen in Figure 8.

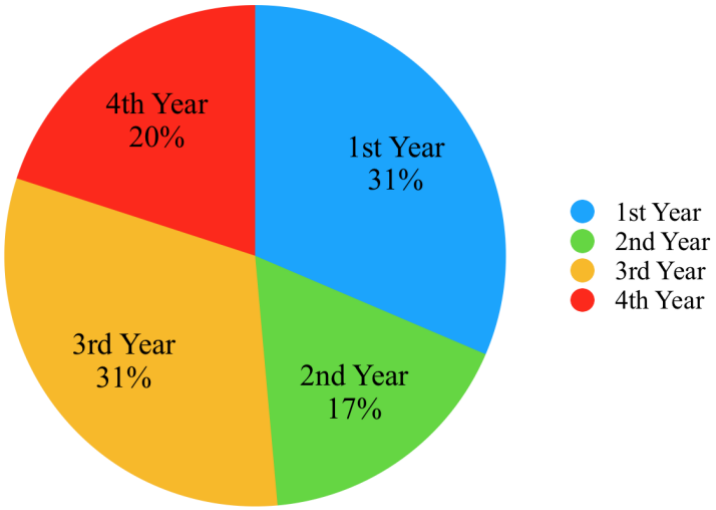


Figure 8: The overall demographic of the gocus group attendees.

4.6.3 Focus Group Process

Through the use of the initial questionnaire, the participants could choose whether or not to take part in the focus groups. This process gave an initial population which was approximately 38% of the school's undergraduate students. The focus groups were then chosen according to the abovementioned process. Each focus group

sample was chosen to ensure that it was diverse, by choosing participants from different years, to ensure that there would be no bias in the answers given.

Each focus group required a minimum of 5 participants, so in order to allow leeway for participants who would not attend, 12 participants were initially invited to account for the "no-shows" on the day of the focus group. The block diagram below in Figure 9 shows the overall population, the sample size for the survey and focus groups as well as the number of participants that attended the focus groups.

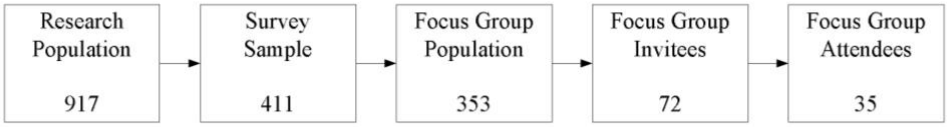


Figure 9: A block diagram showing the process of how the sample was filtered.

Each of the participants were emailed informing them of being chosen for the focus group, along with a participant information sheet and all the relevant details of their focus group session. The participants were emailed closer to the session's date to remind them of the session, and where available (from the questionnaire being completed) a WhatsApp message was sent to some participants to remind them of their session. The process followed for each focus group session was the same. The focus groups were run in lunch breaks during term time at the university and would last between 45 minutes – 1 hour. Each focus group would commence by introducing the researcher and then giving the participants a chance to read the information sheet again.

The consent forms were given to the students, and the procedure was then explained as follows:

- A brief overview of the research was given
- The researcher explained that the participants would be recorded
- The participants were encouraged to give their own views on the questions and that no specific answers were being looked for
- The participants were asked if they felt comfortable with this
- The participants were given the opportunity to leave at any time
- The participants were told that they did not have to answer a question if they were uncomfortable

The focus group recording was then started on a mobile phone. The participants were asked to introduce themselves and let the group know the reason they chose engineering as a career path. After the introductions, the prepared questions were asked in a general manner such that the participants had the chance to answer and discuss with one another.

Several considerations needed to be made with regards to the moderator (in this case the researcher). In some groups the group dynamics were balanced and there were no dominating participants, however in some other groups, the dominating participants needed to be managed. In the case of the dominant participants, the moderator would ensure that the participant was gently asked to allow other participants to give their input and the moderator would encourage those who had not given input into the question to contribute if they wished to. The main role of the moderator is to facilitate the focus group by asking questions to the group, and

if necessary, to re-focus the group should the discussions go too far off topic and if necessary, manage dominant participants.

4.6.4 Focus Group Transcribing and Analysis

Thematic Analysis was used as the analysis tool for the focus group data. Thematic analysis is an iterative process of analysing the data. The ultimate goal is categorizing the data into themes that relate to the research topic and research questions, allowing the researcher to answer these questions (Braun & Clarke, 2006).

There is a general 6 step process to approaching thematic analysis, which has been adapted from Braun and Clarke (Braun & Clarke, 2006) the steps are as follows:

1. Familiarisation with the focus group data
2. Generating features within the data (Codes)
3. Patterns within the codes (Themes)
4. Review and validate the themes from step 3
5. Name the themes
6. Do the analysis discussion

The process is iterative. In step 1, the recorded data is listened to and transcribed (Braun & Clarke, 2006). The researcher has already started to become familiar with the data, but it is important to read the data several times and understand what each participant said. Each time the data is re-read, new features will be understood, and it is through this process that the researcher is able to move to step 2. In step 2 a new document can be created with phrases extracted from the data

(Braun & Clarke, 2006). The second step involves coding, where coding is the first step in understanding the data on a deeper level; it is the process of taking the data and separating the transcription into shorter phrases, while assigning a "code" or meaning to the phrase (Terry, Hayfield, Clarke, & Braun, 2017). After the initial coding step, the researcher can go through this process again and refine these initial codes to be more succinct. Step 3 explores the patterns within these codes to group them together to form themes and to check that the themes are coherent (Braun & Clarke, 2006). Step 4 is to analyse the themes that have been identified and further to check whether there is enough data to warrant a theme or whether the theme is just a code (Braun & Clarke, 2006). Step 4 and 5 include splitting themes into themes and sub-themes if necessary and could also include joining themes together and naming them (Braun & Clarke, 2006). Step 6 is an exploration of the themes and an in-depth analysis of the overall themes and sub-themes (Braun & Clarke, 2006).

The process that was followed throughout the analysis process can be seen in Figure 10. Initially the focus groups were transcribed into individual documents. The focus groups were transcribed word-for-word (as it happened in the session) and each participant was identified and linked to what they said. The transcription of each focus group was then read and re-read over a 2-week period to become familiar with the data. After transcribing, a spreadsheet was created in order to split the transcription into smaller quotations, to have simpler statements.

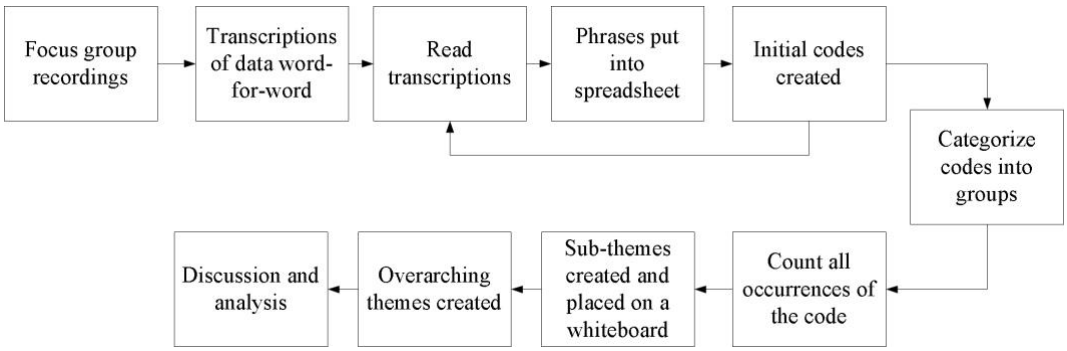


Figure 10: The flow chart of the thematic analysis process for the focus group analysis.

It can be seen from Figure 10 that the spreadsheet was then created with only the phrases, where the initial codes were given to the phrases. This process of coding was repeated twice over the entire dataset to ensure that nothing was missing. The codes were categorised into similar types. This enabled the researcher to view the codes as a whole and refine each theme on its own. These categories of codes were numbered, and a tally was created to determine the frequency of the code, to validate whether the code was significant. The overall sub-themes were then written onto sticky notes and placed on a board, where the overarching themes were constructed and placed together on the board. The write up, which is presented in Chapter 6 was then produced. Throughout this entire process, the codes and themes were constantly rechecked and discussed with the supervisor (who had separately assessed the focus group data)- this was to ensure that the data analysis was as unbiased a process as possible.

The main themes that emerged from the data include various reasons for students choosing the degree, student support issues, success strategies and adjustment to university.

4.7 Research Validation, Reliability and Replicability

Validation of focus groups is crucial to limit bias and inconsistency within data. For focus groups to have validity, there are several aspects that can be put into place. Ensuring that the sample is representative is key, and using the technique of triangulation can assist to ensure that the data and analysis is valid, and the third technique to use is to ensure that data saturation is reached (Bryman, 2012; Statistics Solutions, 2019).

The sample of this research was representative of the overall population, and the sample was chosen based on purposive sampling, so that each of the various areas of the research were chosen equally from the survey respondents. Ensuring that the size of each group complies with the norm in terms of the literature also assists with validity of the sample. According to several different sources (Bryman, 2012; Morgan D. , 1997; Morgan & Hoffman, 2018) focus group sizes can vary from between 4-12. Morgan (1997) states that groups smaller than six participants might be difficult to maintain a conversation, while Bryman (2012) and Morgan & Hoffman (2018) recommend smaller groups when participants are close to the topic and will have a lot to say on the topic. Four out of the five groups contained more than six participants while one of the groups contained five participants. In the group containing five participants it was found that the participants still maintained

discussion fully, and each participant was able to explain their experiences in detail, which gave a richer data set.

The technique of triangulation was performed through ensuring that the research was analysed from different perspectives (Bryman, 2012). Both the researcher, and the supervisor analysed the (anonymised) data, to ensure ethical confidentiality, and to ensure that the analysis was the same from different perspectives. Further, triangulation was used through the analysis with the consistent use of Fisher as a framework.

Data saturation would be reached, if through the analysis process, the results are consistent across the majority of the focus population. The research becomes reliable when the same responses are seen across the data. Since there were several focus groups performed all with the same questions, if there are more of the same responses about the same topic, it will show that the theme is consistent and reliable.

Replicability was ensured in that the same process was adhered to, and the questions asked remained the same in each of the focus groups. The process and the questions could be used in further research, should it be expanded to other schools within engineering and other universities. The focus group process was discussed in detail in section 4.6.3, and the questions used for the focus groups can be seen in Appendix C.

4.8 Conclusion

The research methods have been presented in this chapter. Due to the nature working with human participants, the richest data is found through the use of qualitative methods. This research has introduced the use of focus groups as the main research method in the collection of data. Through the use of focus groups, this research aimed to identify some of the factors that are affecting the students in Electrical and Information Engineering. The focus groups highlighted some of the issues that were addressed in the literature survey and will further be explored in the following chapter. Secondary to the focus groups, quantitative data, through the use of surveys and academic results, will also be used to identify some of the factors affecting our students. The quantitative data will be discussed in Chapter 5, and the focus group results will be presented in Chapter 6.

Chapter 5

Questionnaire Results

The survey results are presented in this chapter. The survey comprised 4 questions relating to language medium at school, financial aid, residence and distance from university. The aim of this survey was to determine the sample for the focus groups, as well as to establish the demographics of the school in terms of these four factors. These factors were all looked at holistically, to determine the focus group sample.

The emphasis for the focus group sample was to provide a comfortable space for the participants to discuss topics relating to their university experiences. The focus groups were thus categorized into these factors, so as to group like students together. Furthermore, the fact that the participants were all from the school of Electrical and Information Engineering (EIE) would provide a space where students were more likely to know one another.

5.1 Survey Sample

The survey was conducted on all the 4 years of study in the school of EIE, in 2017. The number of completed surveys were 411 out of 917 registered students in EIE in 2017. The overall breakdown of the survey completions can be seen in Table 3 below. The survey response rate of approximately 45% for a paper survey is acceptable according to (Nulty, 2008). The response rate being acceptable means that the overall responses (411) are representative of the entire sample size (917).

Table 3: The overall demographic sample of the completed surveys.

Year of Study	Number of completed surveys	Total Number of Students	Percentage completed (%)
1	164	405	40.49
2	141	242	58.26
3	64	175	36.57
4	42	95	44.21

5.2 Language Medium Results

Language medium refers to the language in which the students received their matric tuition. According to Fisher (2011) and van der Westhuizen et al. (2011), English as a second language can affect students' academic performance.

Language medium results are presented in Figure 11. It can be seen that the majority of the students that completed the surveys are first language English speakers. This is not in accordance with the results presented in Chapter 2, but this could mean that all the students that are not first-language English speakers did not participate in the survey, or it could mean that the question for the survey was worded ambiguously. For the focus groups, when purposive sampling is performed this factor will not be included, as it seems as though the question could have been misinterpreted.

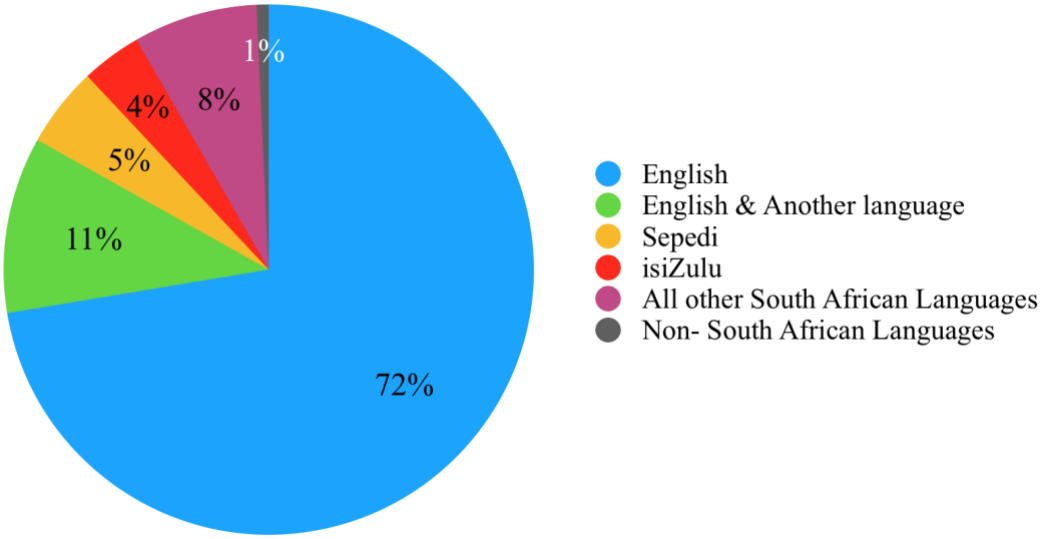


Figure 11: Participant language medium at school.

5.3 Living and Travel Arrangements

The number of students that live in residence versus the students that live off campus is presented below in Figure 12. Since the majority of the students live off campus the time that these students spend travelling is explored and is shown in Figure 13. Approximately 65% of students who do not live in residence spend more than 20 minutes travelling to university each day. About 29% of the students spend more than 40 minutes travelling to university each day, which means that they are spending almost an hour and a half travelling to and from campus each day. Within the survey responses, there were also students that claimed to be travelling up to 2 hours to get to university each day, which suggests that they are spending at least 4 hours travelling each day. The modes of transport vary, from cars; trains; taxis; and buses. It is important to note that studying is not conducive when travelling in public transport due to space limitation. The amount of time that students spend travelling, shows that a significant number of students could be losing out on study time.

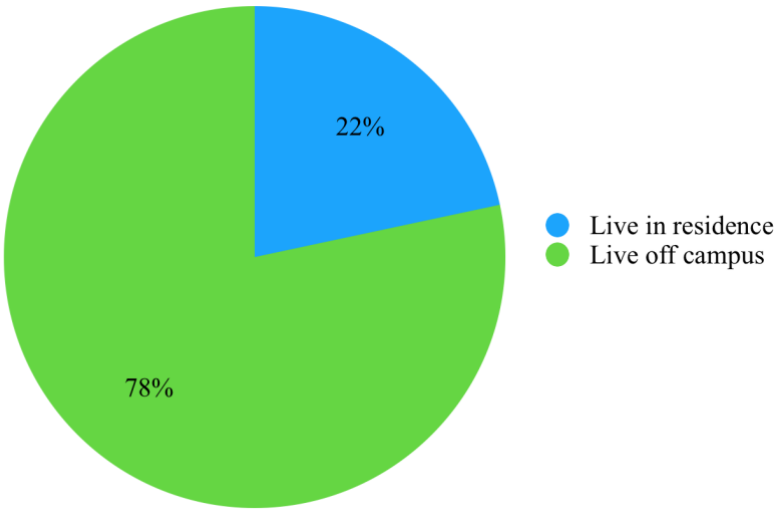


Figure 12: Percentage of students that live in Residence and those that live off campus.

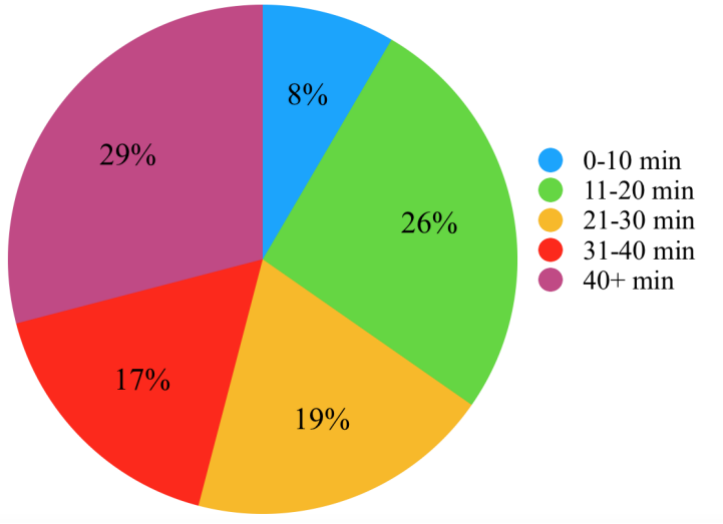


Figure 13: The time students spent travelling to university (one-way).

5.4 Financial Aid

The next factor that was explored, is whether a student has financial aid or not. According to Fisher (2011), there are students who rely on financial aid. These students have strict conditions associated with their bursaries; thus, they have the responsibility to pass without failing. However, this is not always the case as

students are often left with student debt and face the consequence of not being able to finish their degrees. The benefit of having a bursary is being able to study at a university, for students who otherwise would not be able to study. This research will explore the responsibilities of the students with financial aid to determine if they think that their experiences are affecting their academic performance.

In Figure 14, it can be seen below that 58% have financial aid. 42% of students are not reliant on financial aid. Since financial aid has been explored through the literature, it would be important to note whether, from the student's perspective, the effect of either financial aid or the responsibilities that come with financial aid cause significant stresses in their university life.

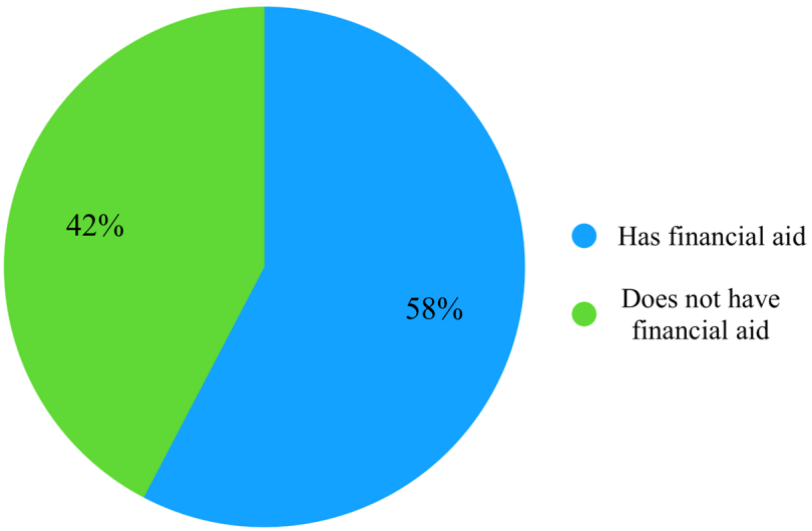


Figure 14: The percentage of students that have financial aid and those that do not have financial aid.

5.5 Conclusion

The survey showed that about 28% of the survey population are not first-language English speakers, approximately 78% do not live in residences near the campus, 65% of whom travel more than 20 minutes to university each day. It was also found that 42% of students do not have any form of financial aid. The questionnaire results were used to determine the focus group sample. It was necessary to identify students in each of these groups and to further explore whether South African students think that they are affected by the academic success factors that were found within the literature. In the next chapter, the focus group results will be presented. Directed questions about the factors raised in the questionnaire, were not used in the focus groups. The focus group approach was to explore the students' experiences throughout their university careers.

Chapter 6

Focus Group Results

Using Fisher's framework and the results of the questionnaire, several themes and factors were explored in focus groups. The aim of the focus groups was to establish whether or not the factors resonated with the students and to understand their stances on a deeper level. Further, the focus groups aimed to uncover any unknown factors that affect students during their studies. The main ideas that were explored from the literature are:

- Choice of Engineering
- Support structures
- Financial aid status
- Where the student lives during term time
- Studying

The questions and ideas explored in the focus groups are related to the above ideas and can be seen in Appendix C. The main focus of the above ideas resulted from the work of Fisher (2011). Fisher's work only included the opinions of academic and faculty staff members, it is therefore useful, to use Fisher's work as a framework, to examine the opinions and experiences of students from their own point of view. Each of the above ideas were structured in a general manner in a question format which initiated discussion between the students and through this, the questions were answered. The results are presented in terms of the themes and

sub-themes that emerged through a thematic analysis. Through the focus groups, there were other themes that emerged, and these themes will also be discussed in this chapter.

6.1 Student Interest

The themes that have been identified under *student interest* emerged from each focus group. Each focus group discussion began with the participants introducing themselves and speaking about their reasons for choosing engineering. This theme encompasses the participants' reasons for choosing engineering as a degree. Throughout the different focus groups, similar reasons resonated overall. Some participants spoke about enjoying Physics and Mathematics at school, knowing a family member/friend in engineering, while others spoke about enjoying taking things apart. Contrasted to this, there were also participants who spoke about not wanting to do engineering and not choosing the degree for themselves.

The sub-themes that emerged from this question are:

- Subject interest
- Subject excellence
- Family interest
- Student disinterest

According to Fisher (2011), students choose engineering for a variety of reasons. More specifically, Fisher states that students are choosing engineering for the following reasons (taken directly from (Fisher, 2011)):

- "*The 'challenge' of engineering*
- *The status or prestige of engineering*
- *Family background*
- *The desire to make a difference, to create and fix things*
- *Ignorance of what engineering is really 'about'*
- *Bursaries*
- *Job prospects*
- *Career flexibility and mobility*"

One of the reasons discussed by Fisher is that of not understanding or having knowledge of what engineering is about. It is noted that some students realise early on in their studies that engineering is not for them, while others tend to stay in engineering and only drop out of the field later on. The faculty seems to be losing students along the way, as a result of the students not having performed any research on their career path. Fisher also discusses the idea of students wanting to make a difference and to fix things, which is a strong reason for choosing engineering. It is also briefly mentioned that some students choose engineering as a second option after medicine as both these degrees are challenging courses.

Cruz & Kellam (2018) present common themes relating to why students choose engineering, that are similar to those noted by Fisher (2011). Cruz & Kellam (2018)

do not, however, suggest that students' reasons for choosing engineering play any role in student success. The outcomes found by Cruz & Kellam (2018), may be helpful in informing which factors will assist with the success of the students.

From the focus groups, the distribution of reasons can be seen in Table 4 below. 60% of the focus group participants chose the degree for the reasons which are linked to either enjoying a subject, being academically strong at a subject or becoming interested in engineering through a family member. While these reasons may imply an informed decision into engineering, there were other students who either did not choose the degree or were not awarded their first option for degree choice. There were also students who chose the degree because of future prospects in the field.

Table 4: The number of students for each sub-theme in the theme of *Student Interest*.

Sub-Theme	Number of Students
Subject Interest and Excellence	20
Influenced by Family/Friend	3
Student disinterest	12

6.1.1 Subject Interest and Excellence

Some students were of the opinion that "the degree chose them" because they have a keen interest in the degree. These students would start off by saying that they either took things apart as a child and wanted to see how things worked or put things back together after taking them apart. This suggests that students with these interests might be more likely to succeed in the degree.

One student says:

> *"The degree chose me actually. It started when I was about 9 years old, I would break electrical stuff apart and screw them back together and they'd work; TVs and things I'd replace things, so they'd work"*

While another student says:

> *"I used to take apart everything. I still enjoy using parts of broken things and turning it into my own stuff"*

These quotes are in line with the nature of the degree in terms of subject interest. One student demonstrated good insight into the nature of electrical engineering, saying:

> *"The reason I chose electrical engineering is because I like computers and software, and electrical is kind of like learning about hardware and software and how they work together, so that was the best option for me."*

Showing an interest in the field, as Fisher (2011) and Kokkelenberg & Sinha (2010) show, is a factor that can attribute to the student's success. This is not the only form of subject interest that emerged from the focus groups. Another trend was an interest in mathematics, physics, and even in electric circuits. Several authors (French, Immekus, & Oakes, 2005; Besterfield-Sacre, Atman, & Shuman, 1997; Geisinger & Raman, 2013), found that an interest in mathematics and science could

contribute to being successful in the degree, but is not the only factor contributing to success in engineering. Having an interest in mathematics or science was confirmed by the comments of a number of students in the focus groups in this study. The focus groups showed that 14% of students chose the degree because of an interest in math and science or excelling at these subjects. One student said:

"When I did my A levels, I did math, Physics and Chemistry. I used to like physics, particularly the electrical stuff, this is why I chose it"

Another student said:

"I just find maths interesting, especially when you learn new things, it's like this is awesome… I really enjoyed it a lot… I chose Game Design and I ended up enjoying the engineering [side of things]"

The focus groups showed that some students chose the degree due to enjoying Mathematics and Physics. These subjects are fundamental to Engineering, and more specifically to electrical engineering.

The above comments align with the work from French et al. (2005), and the notion that an interest in mathematics and physics could assist in the success in the degree. The first student was asked by another participant *"How much did A-levels help you for engineering",* and he responded: *"I didn't struggle much in first year, but then second year you're just like everybody else."* This suggests that A-levels assisted the student to be prepared for 1st year engineering, but the student then

experienced a gap when going to 2nd year. Interest in a subject is therefore not the only factor that assists students in succeeding academically as confirmed by several authors in the field (French, Immekus, & Oakes, 2005; Besterfield-Sacre, Atman, & Shuman, 1997; Geisinger & Raman, 2013). Cruz & Kellam (2018) explained that students who choose engineering due to enjoying a subject in high school, do not fully understand that engineering is the application of Mathematics and Science when solving problems.

The students who actively played with and built electronic or other objects appear to be more successful in their studies. These participants delved deeper into understanding the inner workings of objects, hence their sense of enquiry is heightened since they had previously explored the engineering space and their interest was being fulfilled through their university studies, as discussed by Fisher (2011) and Kokkelenberg & Sinha (2010). Fisher mentions the idea of students wanting to "make a difference, to create and fix things" (Fisher, 2011, p. 43), while Kokkelenberg & Sinha (2010) discuss the idea of students engaging with scientific toys and attending exhibitions at school. Both these ideas strongly correlate with what is found in the focus group data, and shows that there are students within engineering that have been exposed to the field prior to studying the degree. These students expressed a true passion when they explained the reason that they chose engineering, which showed a genuine interest in the field.

While there are some students that chose the degree for the enjoyment of subjects, others chose it because they excelled at the subjects in high school, for example a student mentioned:

"My uncle is also an electrical engineer, that is how I was introduced to engineering. At school I just knew I was good at math and science, and I did art, so I though what is technical but also creative, so I chose engineering."

This student mentioned their reason for choosing the degree initially as being good at Mathematics and Science. However, this student also chose the degree as it has a creative side to it. The quote shows that students who excelled in Mathematics and Science at school as well as having a creative side also have an interest in engineering as discussed by Cruz & Kellam (2018). This can also be seen by another that initially chose Architecture, but decided to change to engineering for this reason:

"There is something about this [Engineering's] structure… I really like that about engineering; it's still technical and there's still room for creativity and design"

The idea of creativity in engineering is explored by Cruz and Kellam (Cruz & Kellam, 2018). Their research shows that some students chose engineering because they believed that the degree would still allow them to use their creative side. The focus groups confirmed that some participants chose engineering as it has a technical side and the possibility of creativity and design.

6.1.2 Family/Friend Influence

8% of students indicated that there was an external influence from family members or family friends. These students knew people that were in the engineering industry, and through knowing people, their curiosity turned into an interest to do the degree. The idea that students apply to engineering because they know someone in their family is an engineer is mentioned in Fisher (2011) as a reason for a lot of students choosing engineering. One student's reason for choosing engineering started with "taking things apart and putting them back together" which falls into the *subject interest* theme, however this student was also introduced through a family member:

> *"My Uncle is also an electrical engineer, so that kind of sparked an interest."*

Another student also mentioned that a family member is an electrical engineer, but, had not realised how broad the field was:

> *"I didn't know how broad our subject was, so I came in thinking 'ok power stations, wind turbines etc', because that what I was exposed to with my uncle…the biggest shock for me was the amount of software that was part of electrical engineering, it's not what you associate with electrical engineering."*

This shows that the student was exposed to a specific side of electrical engineering and had to learn to adapt to the degree. In both of these quotes the interest came from an introduction through a family member.

Another aspect is choosing the degree because the student followed a family member who also studied the degree, for example:

> *"I chose it because my brother was in engineering and it was just kind of a family thing to follow in his footsteps… my first choice wasn't even anything to do with Wits"*

This could be an undesirable reason for choosing engineering, as this participant did not have a passion for the degree as shown by the participant saying: "*I struggle because I just don't have a passion for the course*". As mentioned in (French, Immekus, & Oakes, 2005; Besterfield-Sacre, Atman, & Shuman, 1997; Geisinger & Raman, 2013), those who do not have a strong interest in, and a good attitude toward the degree that they are studying, are likely to not succeed or not persist with the degree.

6.1.3 Student Disinterest

Some students selected engineering as their 2nd or 3rd choice. Some of these students only chose engineering due to requiring a 3rd choice on the entrance form and not being accepted into either their first or second choice.

Many of these students wanted to do Health Sciences degrees and were not accepted into those degrees; as a last resort were forced to accept their 3rd choice. Fisher (2011) discusses that the top students are choosing Medicine as a first choice and engineering as a second, which can be seen in the following examples. In the case of students having to choose their last option - it is evident that these students do not have a passion for engineering.

Some students said:

"They didn't take me for medicine, and they rejected me for Physiotherapy, so the last option was engineering"

"I didn't get into medicine so I looked at both degrees and I thought that biomedical sciences looked a bit too boring, so I chose biomedical engineering"

While another student shows their disinterest:

"Medicine is my passion, but GEMP isn't a certainty and biomedical engineering is incredibly challenging and I'm not passionate about it."

There were students who chose the degree due to external factors or who did not want to do the degree. These students have a passion that lies in another field, and this could contribute to not passing in the required minimum years, or moving to a degree that they are more passionate about. This can be seen in (French, Immekus, & Oakes, 2005; Besterfield-Sacre, Atman, & Shuman, 1997; Geisinger & Raman, 2013), discussing that students that do not have a strong interest toward the degree that they are studying are likely to not succeed or not persist with the engineering degree.

It can be seen that most of the reasons that students chose engineering were accounted for in Fisher's (2011) work, which shows that the students' perspective

explored in the focus groups, and the academics' perspective (from (Fisher, 2011)) are correlated.

6.2 Adjustment to University

Within this theme, all adjustment techniques and struggles are explored. For some students the gap from school to university was big, while for others, school was perceived as a more nurturing environment and lastly, some struggled with discipline and time-management. Other students explained how additional schooling or being educated in another country was beneficial to them. Approximately 71% of all the focus group participants mentioned something to do with adjustment to university. In Fisher (2011), it is mentioned that all students experience that gap from school to university, but need to find a way to manage and cope the gap that they face in their studies.

The overall sub-themes can be seen below in Table 5, that shows that majority of the students are struggling to adapt to the new environment. Fisher (2011) discusses the change in environment, explaining that there are students that have come from rural areas who may struggle in adapting to city life and becoming independent. Many students who come from matric may not be adequately prepared for university academically or emotionally (Fisher, 2011; Nel, Troskie-de Bruin, & Bitzer, 2009). Each of these sub-themes will be discussed in more detail in the following sub-sections.

Table 5: The number of students for each sub-theme in the theme of *Adjustment to University*.

Sub-Theme	Number of Students
Difficult to adapt to a new environment	18
School: A nurturing environment	4
Other Schooling types	2

6.2.1 Adapting to a New Environment: The School to University Gap

The gap from school to university describes the emotional and educational gap between Grade 12 and first year in university. Some students find the workload, and the difficulty of the work a lot to deal with in their first year of university, while others struggle with emotional stress. This could be due to the fact that University is a new environment, with new people and completely new work, as described by Fisher (2011).

A 4th year engineering participant describes this gap as:

"There is a stepping stone missing from learning from a school environment to a university environment."

A 3rd year participant says:

"Self-sufficiency… people don't really get equipped with how to do it"

Lastly a 2nd year participant mentioned:

> *"If I could explain the transition from high school to university, just the work load, it was like being set on fire. It felt unnatural and you're just expected to know everything. It was also really emotionally draining [coming from school to university]"*

The above quotes are all from participants who have been at the university for longer than one year. This shows that after experiencing first-year engineering, they are able to reflect back to their experience, as well as through their observation of first year show that there is a gap experienced by some students. The above quotes show that some students are finding the learning curve from school to university difficult to manage. The quotes above were chosen as these students were experienced at the university and the experience would be different to those of first year students. The quotes also explain that students are experiencing the gap that Academics have mentioned in Fisher (2011). The fact that they are expected to be self-sufficient at university is a daunting experience for some students.

A 2nd Year participant also mentioned:

> *"I actually feel very alone in my degree…I feel like isolated at home as well because you know I'm the most educated person in my family"*

This student felt emotionally drained as they did not have the emotional support or understanding from their family. Students who are the first in their family to go to

university may not have adequate preparation, as their parents have not experienced higher education. According to Fisher (2011), student background plays a role in academic success and persistence. Fisher (2011) mentions that students who are first in their families to attend university, find it particularly difficult to adapt to the environment. A survey performed by the Academic Development Unit (ADU) (Academic Development Unit, University of the Witwatersrand, 2018), shows that 51% of first-year students in the School of Electrical and Information Engineering (EIE) are the first in their family to attend university. Thus, more than half of the first-year class may not be adequately prepared when entering university and could face a larger gap in terms of being prepared and could struggle through first year.

Fisher (2011) also discusses that students who are not 1st language English speakers are likely to battle to understand the English spoken by lecturers. In each of the focus groups, the topic of "language medium at school" was explored. Through the focus groups there were eight participants who explained that they were not First Language English speakers. Three of these students expressed their challenges in adapting to the English university environment. A student who was taught in Afrikaans at school mentions:

"It has taken me 10 months to kind of get around with the English, but I still use a lot more Afrikaans than I do English"

While another student says:

> *"From high school, most of the subjects we were taught in a village language, so when we got to university it was so tough because you are exposed to English throughout- there is no break"*

The above quotes show that the participants are finding it difficult to adapt, with one student stating that it has taken almost the entire year to adapt to speaking English. At Wits, assessments are taken throughout the year and taking ten months to adapt to an English environment could have a negative effect to a student's performance.

Fisher (2011) states that more students entering university do not speak English as a first language, and that these students tend to find adapting more difficult. The second participant shows that they are struggling to adapt through saying "there is no break". The fact that not many participants indicated that they had challenges could be attributed to the fact that some participants may not have felt comfortable disclosing their experiences in a group setting, which is a limitation of focus groups (Morgan D. , 1997). To understand whether the idea of language as Fisher (2011) discusses is actually a factor that affects success or not, further investigation would need to be done, either using interviews or through further focus groups to discuss this topic in more detail.

6.2.2 Financial Aid

Financial Aid was explored by Fisher (2011), and by van der Westhuizen and Barlow-Jones (2011). Through the focus groups, there were only seven participants that mentioned financial aid. According to the survey results from Chapter 5, 58% of students rely on financial aid. Most of the students that did mention financial aid was to the fact that they struggled to obtain bursaries after applying to several companies. There were two students however (who both have financial aid), that alluded to their experience of having financial aid, one participant says:

"I don't see a reason to fail, it's more like motivation for me"

And the other participant says:

"...I'm on a bursary, so I have that constant stress of having to do well, because otherwise I lose my bursary and I can't study anymore"

These participants were the only two that mentioned what their experiences are like as a financial-aid holder, and they have conflicting views. The small population of the participants that discussed this topic is inadequate to conclude whether or not financial aid affects performance. Further investigation would need to be done to explore the theme of financial aid to obtain a more conclusive result.

6.2.3 School: A Nurturing Environment

Some students struggle with the change from school to university, since school is seen as a caring and nurturing environment.

A few students struggle to get used to the new environment. As one student mentions:

"We are often nurtured in school, and here in terms of a learning environment you aren't"

Another student describes the difference between his schooling and university experience:

"I came from a private school and they really do care about you and spoon feed you. Here it was a bit different, the lecturers don't know you and they don't care about you, you have to sort yourself out, they don't remind you about tests and things"

The idea of coming from a good school is discussed by Fisher (2011). Fisher mentions that students from good schools may find the school to university gap more significant since "they have been spoon-fed and had things hammered into them" (2011, p. 50). Which is shown by the above student who is experiencing the difference between schooling and university.

6.2.4 Types of Schooling

While some students seem to struggle with the environment change, others who completed A-levels or the equivalent in another country, or those that did additional subjects in Matric such as Advanced Programme (AP) Mathematics struggled less.

One student mentioned that it assisted with reducing the gap from school to university:

"When I did my A-levels…I didn't struggle much in first year, but then in second year you're just like everybody else."

The 1st year courses are predominantly Mathematics and basic Sciences which are the basis for A-level subjects, but in 2nd year, the focus turns to Engineering Sciences where problem-solving techniques become more prominent and where the theory learned in first year is applied.

A second student explained that having done AP Mathematics at school prepared them for university mathematics:

"I was lucky because I took AP maths in high-school so it was already an introduction to the maths… I taught myself science since grade 10. That was good preparation for University. I feel like a lot of it was easier because it's stuff that I'm interested in"

It was an advantage that this student was able to teach themselves Science at school, becoming a more independent learner. This student believes that both taking AP Mathematics and being able to teach himself Science helped prepare him for university. AP Mathematics includes part of the first year mathematics engineering syllabus. Finally, this student also found university easier since he was more interested in the subjects that he was doing. This further strengthens the claim from

the literature that students who have an interest or a passion in the field appear to struggle less in engineering.

In both sub-themes, it can be seen that there is a gap between 1st and 2nd year, in addition to the gap between school and university. The gap from school to university does not seem to be affecting the students as much as the gap from 1st year to 2nd year. The students who completed A-levels at school, were less affected by the school to university gap.

6.3 Support in All Forms

This theme emerged from the focus groups when the idea of support was discussed. In this theme *support* encompasses all forms of support, including academic assistance, studying assistance, family support and any external support that the engineering students may have, that allow them to get through their day-to-day lives at university. The sub-themes that arose through the analysis are:

- Emotional stressors
- External stressors
- Success strategies

The overall sub-themes can be seen in Table 6 below. This table shows each sub-theme with the frequency that each of these appeared in the focus groups. The table shows that students experience many emotional stressors. However, there are also many success strategies that the students have found. About 31% of the focus group

Table 6: The overall sub-themes along with the frequency in the theme of *Support*.

Sub-Theme	Frequency
Emotional Stressors	53
External Stressors	11
Success Strategies	78

participants experience external stressors such as living far from university and having transport issues. Fisher (2011) states that there are students that have travelled from rural areas to study in urban areas, and they could face challenges in adjusting to university. These challenges could be seen as the *emotional stressors* and the *external stressors.* It is, however, crucial for the students that have found ways of coping to share with those who are struggling. The sub-themes will be explored in more detail below.

6.3.1 Emotional Stressors

Emotional stressors refer to the support systems that the students feel that they do not have. These support systems mainly revolve around family and friends, while some students feel that they are lacking the academic support that they need.

This sub-theme introduces some of the issues that students seem to be facing in their studies, as well as the students that have found ways to navigate through these stresses. Students said that their families do not understand the pressures and the stress of the degree and they experience additional pressure from their family to perform well academically. Other students say that their families do not understand when they fail. The students are left feeling isolated and without any emotional support through their degrees. Fisher (2011) mentions that some students who live

at home may not be able to talk to anyone regarding their studies, personal issues and this could link to the fact that there are also students who are the first in their family to attend university, whose parent's do not understand the pressures of the degree. Students also feel that they do not have time to do anything else except work, which also leaves them feeling isolated since they do not socialise and put most of their time into their work.

The issues that some students face, include not getting assistance from peers, as well as emotional breakdowns. A student mentioned:

"…I remember it was before the first software test that we wrote, I actually had an anxiety breakdown…I had to call my mom to pick me up because I physically could not drive"

This quote shows that this student experienced an extremely stressful situation. Another student said: *"I am always anxious, and I'm always tired"* when talking about the pressure of the degree and stress of the degree.

Approximately 20% of the focus group participants showed stress or anxiety. If all the components are grouped together it shows that stress is an important factor in these students' day-to-day lives:

- Stress/Anxiety - 20%
- Family pressure to do well – 18%
- Family do not understand the pressures of the degree – 46%

Stress is often overlooked, and this research has shown that it is an important concern to students. The proportion of students facing stress is large and is a likely cause for poor academic performance.

About 46% of the participants stated that the support that they received from home was minimal, and that their families did not understand the stress of the degree, let alone the difficulty of the degree. These students find it difficult to speak to their parents, as their parents cannot understand their struggles since they believe their child is a high achiever (from school). One student says:

"I do feel isolated at home as well because you know, I'm the most educated person in my family"

Since this student's parents have not been through the university system, they feel that their parents cannot assist them with their higher education journey. Another student explains that their father did not understand their failure:

"My father didn't understand when I failed, but now where he works they're teaching them stuff, so now he kind of understands what I'm going through when I say I have something that I need to submit"

This parent did not understand his child's struggles, because they had not experienced this type of learning environment. However, when this father experienced education through his work, he was able to empathise with his child. In this case, and in the case of 51% of the School of EIE students, there are parents that do not have the insight into the learning environment that the students are

experiencing. The focus groups showed that this is an added stress to students, which could affect their academic performance.

6.3.2 External Stressors

External stressors refer to aspects of a student's life that cannot be controlled and that, in their experience is affecting their academic performance. This sub-theme explains students' struggles with living far from the university campus. Traveling far from home to get to university is discussed by Fisher (2011). Fisher mentions that students who travel far may find adapting to the university environment more difficult, and could also experience transport challenges (for example traffic, or taxi protests, or not being able to afford transport costs in some cases). Fisher (2011) discusses that students living in student accommodation might assist with academic success, as it provides the student with a supportive environment that is conducive to studying and learning. However, Fisher (2011) also mentions that some students who live at home may not be able to talk to anyone regarding their studies, personal issues and won't have anyone to work with at home, which could attribute to the student struggling to navigate through the challenges of university. Approximately 29% of the focus group participants reported struggling with public transport or traveling to university, when talking about stress.

The following three quotes explain the feelings of those that have to travel a long way to and from university each day, the three participants were all part of different focus groups:

"When I came in my first year, I didn't have a sponsor, so I used to travel from home in Tembisa and take a train, so it was like 2 hours to come and 2 hours to go back home, so that got into my time."

"Transport for those who commute or travel from far places, it actually takes a toll on you. You find yourself more tired and you don't have as much time to study. It becomes a problem"

"Distance plays a huge part in how you kind of cope with work."

The common thread amongst these quotes is that "it takes a toll". Through these quotes, students have expressed their stress, and the fact that they do not have much time to study. The first student explains later that it was useful to work in groups and also made use of the university library and computer laboratories to study, and shows that despite a difficult situation, they were able to overcome the challenge. The second and third students show that it is difficult to keep up with the demands of an academic programme with a large course load, and it contributes to how one copes with these stresses.

In one of the focus groups, the discussion continued among the group of students. They described how they were struggling and asked one another how they coped

with travelling far. Students said that they would work when they got home and that they *"just don't sleep".* This suggests that the students that live far do not spend enough time sleeping as they still tried to get through the work load.

6.3.3 Support Success Strategies

This sub-theme presents coping strategies that counteract the previous 2 sub-themes of *emotional and external stressors*. Even though many students are struggling with emotional stress, some have found strategies to assist them in coping with the university environment. Students feel that they benefit from the support that they receive from their peers, either in the form of studying or working with other students in the degree. This not only refers to working with students within the same year of study, but rather creating a network and learning to communicate with students from different years of study. This theme encompasses all the strategies that students have found to help them.

One student says that their friends are always there to help:

> *"I feel like I have so much support from my friends; maybe it's just my friends, but if I have a problem, they're always willing to help."*

This student finds value in working with their peers, who are there to support them, both in an emotional and an academic manner.

EIE students have a computer laboratory called D-Lab exclusively for the students in the school. Some students feel more comfortable knowing that others in the

laboratory are from the same school, and have done the same subjects, hence they are able to speak to other students and ask for help. One student said:

"There are always people in D-lab that can help you."

Another student agrees with this sentiment and (after having isolated themselves previously from asking for assistance) says: (it's a matter of):

"Putting your pride aside and asking for help and saying

'Listen, I'm struggling with this'".

These two quotes show that there are always willing students in the laboratory that offer assistance to others. It benefits everyone if there is a culture of helping one another. This could assist the students that feel like they are alone and cannot find study groups. One student said: *"You know you're not alone and you're more comfortable to talk to someone that has recently been there".* Students agree that *"I'm always too scared to ask the 2nd and 3rd years, because they look so intimidating".* Currently, the culture is not as welcoming as some make it seem. Students need to work together to achieve a better rapport with all students in the school.

Some students only realise after failing that they need to work with others. It seems to trigger the belief that the students are not able to pass courses without the help of one another. A student says that after failing:

> *"We started applying an Ubuntu strategy…We created a network, so if someone understood then we will learn from them".*

The definition of Ubuntu is (Thompsell, 2018) "*the connectedness that exists or should exist between people*" which explains that this student and their friends began working together and solving problems to find a more effective method of passing modules.

Students have various ways of working together in their studies, for example:

> *"We would only work together to do past papers just before the exam. We weren't studying the concepts [together], you make sure you cover the topics alone [first]."*

Several students shared this sentiment. Students knew that there was benefit in working in groups once they understand the concepts. Approximately 50% of students said that they benefitted from studying in groups and networking with their peers. This is positive and could help to increase academic performance, while nurturing a caring environment in the school.

Another prominent factor is that of asking for help from other years of study. Many students see the benefit in asking for assistance from the other years of study. It

seems as though the use of the common computer laboratory is facilitating this collaboration amongst the years, as can be seen by the following quotes:

"I spend a lot of time in D-Lab. A lot of the 2nd and 3rd years are there so it's the same faces and you kind of just build connections, everyone is generally nice though."

"…They are always there to help if you need help and ask, they are willing and they explain in such a way that they you get to understand."

"Group work has assisted me a lot"

It can be inferred that students are benefitting from one another and learning to communicate with one another through asking for assistance.

These students imply that their academic performance is better since they are able to collaborate with their peers. They understand that working together will assist them in their university careers.

The university also plays a large role in the support of the student. Some students believe that:

"Some lecturers are more supportive than others"

A student mentioned the value in attending lectures, as it is important to understand the concepts:

> *"There is a lot of value in going to the lectures, because especially in our field, you know integration is integration, so most of the time you are doing technical things, not like a language course, where comprehension is important but rather what he shows you on the board is really important."*

Some students who find lectures beneficial and despite some lecturers being difficult to understand, because the concepts and knowledge being conveyed is important to them. Students are not only getting assistance from their peers, but also finding value in asking their lecturers for help. Some students, however, find it difficult to approach lecturers. One student said: *"In first and second year I really struggled to take advantage of that [asking lecturers for assistance]"*. It is important to be cognisant of the fact that many students that may be struggling but are afraid to ask for help, so asking for assistance should be encouraged in lectures to mitigate the number of students that are struggling.

To support Engineering modules in Wits university there is an Academic Development Unit (ADU). The ADU organises several supplementary tutorials aimed at students that require extra assistance with their modules. Not all the prescribed courses are offered by the ADU, but the "problem" modules are offered. The problem modules are identified by marks at the end of first year engineering. The ADU has classes year-round to assist with these subjects, as they are usually

the courses with low pass rates. Many students benefit from these courses as can be seen from:

"I did that [ADU] for maths and that helped me"

Another benefit of the ADU is that some of their courses are captured online, so students do not have to attend the classes, but are able to watch the videos. Some students benefitted from the video assistance:

"I watched all the lecture videos and that really helped me."

During the analysis of this theme, the overall support from peers was mentioned and the categories are grouped by:

- Help from other years of study 34%
- Group work/Networking 51%

This suggests that the students find it beneficial to work in groups and it could assist with improving academic performance. This is in line with Trengove's conclusion that students find it beneficial to learn from their peers, as well as exploring new methods of learning through their peers (Trengove, 2017).

Since Engineering is fundamentally based on problem solving, it should be second nature to work in groups to solve problems.

This theme explored the success strategies of several students, which could be a significant focus for all students and academics, to ensure that students create a strong support structure for themselves throughout the degree, as it will assist them

in their academic performance. Since there are coping mechanisms that work for some students, it is imperative that we empower all students with these mechanisms so that they have all the available tools to be successful throughout their studies.

6.4 Limitations of the Research

In research there are always limitations that could affect the results. One such limitation is that of researcher bias (Bryman, 2012; Morgan D. , 1997). In any qualitative research, the researcher cannot remove themselves completely from the research, and thus the researcher's lens can be biased. The researcher cannot remove themselves from qualitative research (Bryman, 2012). The researcher was aware of this through the qualitative process and was reflexive in between each of the focus groups, transcription of each focus group, as well as analysis of the data. The researcher ensured that the process defined in the Chapter 4 was followed with each group, and ensuring not to direct or guide participants to answers, but rather letting the discussion progress naturally within the group. This ensured that the data emerging from the focus groups was organic. Furthermore, throughout the analysis process, triangulation was used to ensure no bias was imposed on the analysis. The fact that the researcher was aware of the bias, assisted with ensuring that there was minimum bias in the analysis and write up of the research.

Focus groups are also limited in that the researcher relies heavily on participant interaction and engagement with the topic and that the researcher cannot in any way bias or influence the participants but only introduce the conversation with topics.

Another limitation of focus groups, is that participants may not want to disclose certain things in a group discussion but may prefer feel more comfortable in a one-on-one situation (Morgan D. , 1997). For example, the fact that language and financial challenges and discussions were not mentioned as prominently, could attribute to the fact that participants were not comfortable talking about their experiences with financial aid in a group setting.

The final limitation of this research is the fact that only one branch of engineering was observed. For a more generalised conclusion, this research could be repeated across all branches of engineering at Wits University, and further carried out at all other universities in South Africa.

6.5 Conclusion

The focus group results and analysis have been presented in this chapter. The main themes emerging from the focus groups show that there are several factors that students perceive as affecting their performance in their undergraduate studies, namely choice of engineering, the strength of their support system, along with feeling isolated and living distance.

The themes that emerged from the focus groups are:

- Student interest
- Adjustment to university
- Support in all forms

Student Interest showed that students have chosen the degree for various reasons. Subject interest and excellence, influence from a family member or friend were advantageous reasons for choosing engineering.

Some students find the gap from school to university manageable but they feel that there is a gap from first to second year. This could mean that students are finding benefit in the ADU and are finding ways to manage the workload in first year. Students who attend schools that have A-levels or who took AP mathematics at school seem to find 1st year easier, and thus for them the gap from school to university smaller. These different schooling environments seem to assist with navigating 1st year, but some students still struggle in second year.

Stress, anxiety and family pressure and understanding are all factors that the majority of students are facing. Students seem to be experiencing a lot of stress in their degrees, with little understanding from their families. Stress is shown in students' performance, where students who are under stress seem to struggling to keep up with the workload.

Among all the stressors that students face, there are also a lot of success strategies for navigating through university. Students benefit from the ADU in first year, and it seems that students who attend ADU tutorials seem to think that it helped them. Other students benefit from studying with each other and working in the computer laboratory. Through the students' experiences, the idea of networking and Ubuntu are positive strategies to coping with engineering at university.

Chapter 7

Conclusion

The work by Fisher (2011), was used as a framework for this study. The framework was used for looking at factors that students perceive as affecting their studies at university and also assisted in limiting the researcher bias. The researcher bias was limited as the framework helped to guide the research. Fisher's work showed that, from the academic staff's perspective, the factors affecting students' academic performance are: reasons for choosing engineering that are not aligned to being interested in the field; having to travel long distances; and having to adapt to the changes from school. Other factors discussed by Fisher (2011) include students who are not native English speakers who may find it difficult to understand lecturers, as well as financial aid and the stresses that come with that. Fisher discusses the idea of student accommodation facilitating a better learning environment for students and assisting students with adjusting to the new aspects of student-life. According to Fisher (2011), support from academic staff, as well as having a strong support structure have a positive effect on students' studies at university.

This study looked at the factors that affect academic success from the students' perspective. To gain the student's perspective, focus groups and surveys were used.

The overarching themes that emerged from the focus groups include:

- Student interest
- Adjustment to university
- Support in all forms

Student interest ranged from interests in engineering subjects to interest in completely different degrees. The literature shows that it affects academic performance when a student is not interested in engineering (Besterfield-Sacre, Atman, & Shuman, 1997; French, Immekus, & Oakes, 2005; Geisinger & Raman, 2013; Kokkelenberg & Sinha, 2010; Painter, Snyder, & Ralston, 2017).

Adjusting to university is difficult for some students. The gap from school to university was reported as an issue (Fisher, 2011), but this research showed that some students find that there is more of a gap between first and second year. The gap, therefore, is not only from school to first year, but the gap from first year to second year is affecting students' performances significantly.

The last theme explores the student's support structures. The theme shows the importance of a support structure when studying. Students are facing a lot of pressure from their families to do well, and they are under a lot of pressure to keep up with the work-load in each of the years. Students feel that stress is affecting their performance. The survey showed that there are students who are travelling close to one and a half hours per day. The focus groups confirmed that students who live far are under extra pressure as they spend a significant amount of time travelling to and from university and have less time to study.

According to the literature, financial aid, student accommodation and English as a second language affect the performance of students at university. According to this research, these factors did not emerge as affecting academic performance for students studying engineering. A possible reason for this is that the focus group population was inadequate for conclusions of the above themes to be found.

Future work could include a quantitative study to determine whether the factors can be quantitatively validated. At present, it cannot be causally determined whether these actually affect students' performance or not.

7.1 Recommendations and Future Research

The purpose of this research was to use Fisher's work as a framework to look at factors that affect academic performance in engineering. Through investigating these factors, academic staff can be better informed of the student experiences and intervene where necessary.

Firstly, this work has shown that students face tremendous emotional stress and that the university's response is inadequate.

Secondly, students need to be better informed of engineering as a career, as well as what the degree entails, so that they choose their degrees wisely. The university could have more in-depth open days, or more information about engineering for school students.

Thirdly, by understanding the students' backgrounds, the university can provide more support to help them prepare for university or to cater for these students

through support programs like the Academic Development Unit (ADU), but throughout their degrees. Further to this, since the majority of the students are the first generation in their families to come to university, it may be helpful to prepare the families of these students by explaining the pressures of the degree and better informing them of the process.

Finally, students need to be equipped with strategies to succeed. Through encouraging group work and group studying, students may be more comfortable to ask for assistance and helping each other in their studies. Creating a more welcoming environment for the student might be useful. Mentoring groups can be introduced where there are students from each year that can assist each other and talk to each other about work related and other issues, thus creating a path of communication, while also providing students with emotional support.

Further research should be conducted using these factors to determine the extent to which they affect academic performance. There is a need to minimise the failure rate and maximise the throughput rate in South Africa, so it would be beneficial if a quantitative study was performed to determine which factors strongly affect academic performance. A predictive model could be implemented, using data science techniques and machine learning, to identify students at risk of failing throughout their university careers. This model will help to identify students that need interventions, and the form the intervention should take.

7.2 Conclusion

This research aimed to identify factors that affect academic performance, through the student experience. In doing this, the researcher was able to use Fisher's results (Fisher, 2011) as the main framework for comparing results from this study, as well as other literature. The focus was on Fisher's work since he performed the same study, but through the lens of the university staff and this study looked at the same factors from the student perspective.

The literature review highlighted that academic performance is dependent on many things, namely: interest in engineering, the student's background- including home language, traveling long distances to university, the change from rural to urban for university, funding, academic preparedness and the student's support structure, as well as the student's academic history.

This research aimed to either confirm or reject these factors found in literature as affecting academic performance as well as being open to other factors emerging through the data. A mixed-methods explanatory research approach was used in this research and included academic data analysis and surveys as the quantitative portion, and focus groups as the qualitative portion. The use of quantitative data assisted in validating the research problem, as well as assisting with the focus group sampling. The focus groups led to rich data, which led to a deeper understanding of the students' experiences.

It was shown in Chapter 6 that the factors that students believe to be affecting academic performance in a negative manner are:

- Disinterest in the degree
- Lack of support from family
- Living far from university

The factors that students perceive as assisting them in their academic performance in a positive manner are:

- Studying in groups
- Asking for assistance
- ADU support
- Attending lectures

The factors that appeared in Fisher's (2011) work, but did not emerge prominently from the analysis of the focus groups are:

- Financial-aid
- Language

These two factors appeared in the focus groups, but did not appear as prominently as in Fisher (2011). This could be due to the fact that the participants did not feel comfortable talking about these challenges in a group setting, or it could be that these are not factors that students find affect their performance. However, for future work, these topics could be further investigated through the use of interviews or more focus groups, as these appear in literature as important factors affecting

performance (Fisher, 2011; Nel, Troskie-de Bruin, & Bitzer, 2009; van der Westhuizen & Barlow-Jones, 2011).

The results of this research showed that attempting to solve the throughput rate in engineering is a complex task. However, when comparing to the framework (Fisher, 2011) it can be seen that the factors that agree from both the perspectives of academic staff and from the students' perspective that affect their studies are:

- Reason for choosing engineering
- Adjusting from school to university
- Having to travel long distances
- Academic support
- Support structure outside of academics

This research touches the surface of identifying the initial direction for a solution to the problem of student throughput. This research provides insight into the student experience at a single school in a South African University, which can guide further research in this field toward a robust solution.

References

Academic Development Unit, University of the Witwatersrand. (2018). FEBE-First Year Survey 2018 [EIE]. Johannesburg: University of the Witwatersrand.

Academic Development Unit, University of the Witwatersrand. (2018). *ADU FEBE Through-put Short Report.* Johannesburg.

Besterfield-Sacre, M., Atman, C. J., & Shuman, L. J. (1997). Characteristics of Freshman Engineering Students: Models for Determining Student Attrition in Engineering. *Journal of Engineering Education, 86,* 139-150.

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology, 3*(2), 77-101.

Bryman, A. (2012). *Social Research Methods* (4th ed.). New York, USA: Oxford University Press Inc.

Case, J., Marshall, D., & Grayson, D. (2013). Mind the gap: Science and engineering education at the secondary-tertiary interface. *South African Journal of Science, 109*(7/8), 1-5.

Cohen, L., Manion, L., & Morrison, K. (2000). *Research Methods in Education.* New York: Routledge.

Council on Higher Education. (2012). *VitalStats: Public Higher Education 2010.* Retrieved 02 28, 2017, from http://www.che.ac.za/sites/default/files/publications/vital_stats_public_higher_education_2010.pdf

Council on Higher Education. (2013). The Higher Education Qualifications Sub-Framework. Pretoria, Gauteng, South Africa: Council on Higher Education (CHE).

Council on Higher Education. (2013). *VitalStats: Public Higher Education 2011.* Pretoria: Council on Higher Education. Retrieved 02 28, 2017, from http://www.che.ac.za/sites/default/files/publications/CHE_VitalStats_2011.pdf

Council on Higher Education. (2014). *VitalStats: Public Higher Education 2012.* Retrieved 02 28, 2017, from http://www.che.ac.za/sites/default/files/publications/VitalStats%202012%20Web_0.pdf

Council on Higher Education. (2015). *VitalStats: Public Higher Education 2013.* Pretoria: Council on Higher Education.

Council on Higher Education. (2016). *VitalStats: Public Higher Education, 2014.* Pretoria: Council on Higher Education. Retrieved 02 22, 2017

Council on Higher Education. (2017). *VitalStats: Public Higher Education, 2015.* Pretoria: Council on Higher Education. Retrieved 02 22, 2017, from Council on Higher Education South Africa.

Council on Higher Education. (2018). *VitalStats: Public Higher Education, 2016.* Pretoria: Council on Higher Education.

Creswell, J. W., & Plano Clark, V. L. (2011). *Designing and conducting mixed methods research.* London: Sage Publications.

Cruz, J., & Kellam, N. (2018). Beginning an Engineer's Journey: A Narrative Examination of How,When, and Why Students Choose the Engineering Major. *Journal of Engineering Education, 107*(4), 556-582.

Department of Higher Education and Training. (2014). National Scarce Skills List: Top 100 occupations in demand. Pretoria: Department of Higher Education and Training.

Engineering UK. (2018). *The state of engineering Key facts 2018.* Retrieved October 2, 2018, from https://www.engineeringuk.com

Fisher, G. (2011). *Improving Throughput in the Engineering Bachelors Degree: Report to the Engineering Council of South Africa.* Glen Fisher Consulting.

French, B., Immekus, J., & Oakes, W. (2005, October). An Examination of Indicators of Engineering Students' Success and Persistence. *Journal of Engineering Education, 94*(4), 419-425.

Geisinger, B. N., & Raman, D. R. (2013). Why They Leave: Understanding Student Attrition from Engineering Majors. *International Journal of Engineering Education, 29*(4), 914-925.

Haggis, T. (2009). What have we been thinking of? A critical overview of 40 years of student learning research in higher education. *Studies in Higher Education, 34*(4), 377-390.

Kokkelenberg, E. C., & Sinha, E. (2010). Who Succeeds in STEM Studies? An Analysis of Binghamton University Undergraduate Students. New York City: Cornell University ILR School DigitalCommons@ILR.

Li, K. F., Rusk, D., & Song, F. (2013). Predicting Student Academic Performance. *Seventh International Conference on Complex, Intelligent, and Software Intensive Systems* (pp. 27-33). IEEE.

Morgan, D. L. (1997). Focus Groups as Qualitative Research. SAGE.

Morgan, D., & Hoffman, K. (2018). Focus Groups. In SAGE Handbook of Qualitative Data Collection (pp. 250-263). London: SAGE Publications.

Nel, C., Troskie-de Bruin, C., & Bitzer, E. (2009). Students' transition from school to university: Possibilities for a pre-university intervention. *South African Journal of Higher Education, 23*(5), 974-991.

Nulty, D. D. (2008). The adequacy of response rates to online and paper surveys: what can be done? *Assessment & Evaluation in Higher Education, 33*(3), 301-314.

Painter, J. K., Snyder, K. E., & Ralston, P. A. (2017). Why Engineering? Students' reasons for choosing an engineering major. *American Society for Engineering Education.* Ohio.

Radu, S. (2018, August 23). *STEM Worker Shortage at a Crisis, Survey Shows.* Retrieved October 2, 2018, from https://www.usnews.com/

School of Electrical & Information Engineering. (2017). *Electrical Engineering Degree Programme: Report prepared for the Engineering Council of South Africa Accreditation Visit.* University of the Witwatersrand , Johannesburg.

Statistics Solutions. (2019). Validity in Qualitative Research. Retrieved from Statistics Solutions: Advancement Through Clarity: www.statisticssolutions.com

Terry, G., Hayfield, N., Clarke, V., & Braun, V. (2017). Thematic Analysis. In *The SAGE Handbook of Qualitative Research in Psychology* (pp. 17-36). London: SAGE Publications Ltd.

The Government of the Republic of South Africa. (2002). South Africa's National Research and Development Strategy. Pretoria, South Africa: The Government of the Republic of South Africa.

Thompsell, A. (2018, 03 23). *Get the Definition of Ubuntu, a Nguni Word with Several Meanings.* Retrieved 05 05, 2018, from https://www.thoughtco.com/the-meaning-of-ubuntu-43307

Trengove, E. (2017). Peer interaction as mechanism for providing timely and accessible feedback to a large undergraduate class. *International Journal of Electrical Engineering Education, 54*(2), 119-130.

University of the Witwatersrand. (2017). *Description of Residences*. (University of the Witwatersrand) Retrieved 07 15, 2017, from https://www.wits.ac.za/accommodation/description-of-residences/

University of the Witwatersrand. (2018). *NSC Admission Requirements*. (University of the Witwatersrand) Retrieved 07 01, 2017, from https://www.wits.ac.za/undergraduate/entry-requirements/admission-requirements-nsc/

Vallerand, R. J., Pelletier, L. G., Blais, M. R., Briere, N. M., Senecal, C. B., & Vallieres, E. F. (1992-1993). Academic Motivation Scale (AMS-C 28). *52 & 53*. Educational and Psychological Measurement.

van der Westhuizen, D., & Barlow-Jones, G. (2011). The Role of Digital Literacy in the Academic Performance of First-Year Students in an Information Technology Course. *Proceedings of World Conference on Educational Multimedia, Hypermedia and Telecommunications* (pp. 873-878). Johannesburg: association for the Advancement of Computing in Education (AACE).

Appendix A

Ethics Approval Documents

A-1 Introduction

The purpose of this document is to provide the relevant ethics documents and university permissions. This document contains the letters from the Deputy Registrar, Head of School of Electrical and Information Engineering at the University of the Witwatersrand, as well as the ethical clearance certificate.

A-2 Permission from Deputy Registrar

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

OFFICE OF THE DEPUTY REGISTRAR

19 July 2017

Ms Alessandra Chiara Maraschin
Student number 469699
School of Electrical and Information Engineering

TO WHOM IT MAY CONCERN

"Determining the predictors for success in Engineering studies"

This letter serves to confirm that the above project has received permission to be conducted on University premises, and/or involving staff and/or students of the University as research participants. In undertaking this research, you agree to abide by all University regulations for conducting research on campus and to respect participants' rights to withdraw from participation at any time.

If you are conducting research on certain student cohorts, year groups or courses within specific Schools and within the teaching term, permission must be sought from Heads of School or individual academics.

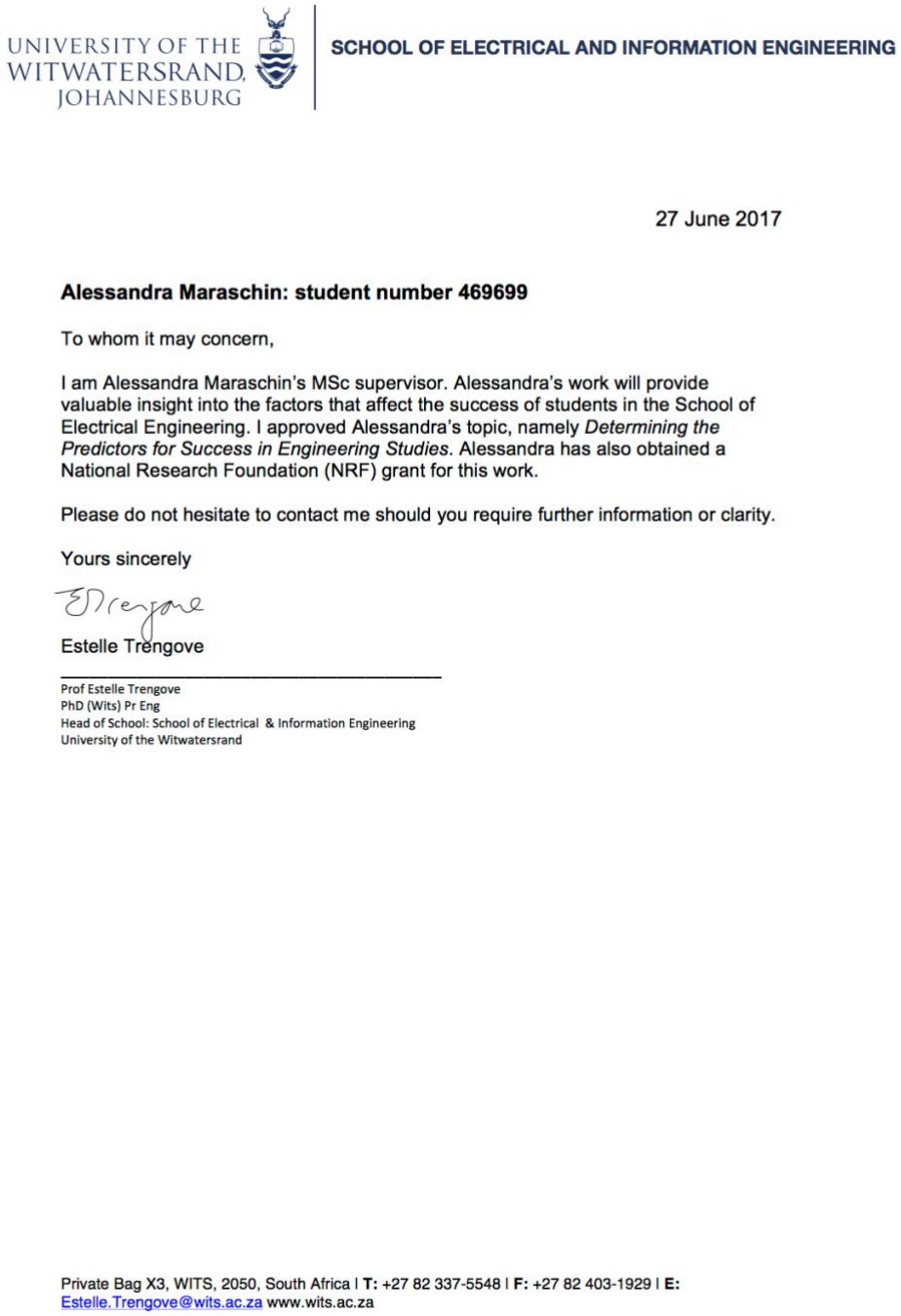
Ethical clearance has been obtained.

Nicoleen Potgieter
Deputy Registrar

Private Bag 3, Wits, 2050, South Africa | T +27 11 717 1204/8 | F +27 86 553 2271 | www.wits.ac.za

Figure 15: Showing the approval letter from the Deputy Registrar.

A-3 Permission from Head of School



UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

SCHOOL OF ELECTRICAL AND INFORMATION ENGINEERING

27 June 2017

Alessandra Maraschin: student number 469699

To whom it may concern,

I am Alessandra Maraschin's MSc supervisor. Alessandra's work will provide valuable insight into the factors that affect the success of students in the School of Electrical Engineering. I approved Alessandra's topic, namely *Determining the Predictors for Success in Engineering Studies*. Alessandra has also obtained a National Research Foundation (NRF) grant for this work.

Please do not hesitate to contact me should you require further information or clarity.

Yours sincerely

Estelle Trengove

Prof Estelle Trengove
PhD (Wits) Pr Eng
Head of School: School of Electrical & Information Engineering
University of the Witwatersrand

Private Bag X3, WITS, 2050, South Africa | **T:** +27 82 337-5548 | **F:** +27 82 403-1929 | **E:** Estelle.Trengove@wits.ac.za www.wits.ac.za

Figure 16: Showing the approval letter from the Head of School.

A-4 Ethical Clearance Certificate

Research Office

HUMAN RESEARCH ETHICS COMMITTEE (NON-MEDICAL)
R14/49 Maraschin

CLEARANCE CERTIFICATE	**PROTOCOL NUMBER: H17/05/16**
PROJECT TITLE	Determining the predictors for sucess in engineering studies
INVESTIGATOR(S)	Ms A Maraschin
SCHOOL/DEPARTMENT	Electrical and Information Engineering/
DATE CONSIDERED	19 May 2017
DECISION OF THE COMMITTEE	Approved
EXPIRY DATE	10 July 2020

DATE 11 July 2017 **CHAIRPERSON** (Professor J Knight)

cc: Supervisor : Professor E Trengove

DECLARATION OF INVESTIGATOR(S)

To be completed in duplicate and **ONE COPY** returned to the Secretary at Room 10004, 10th Floor, Senate House, University. Unreported changes to the application may invalidate the clearance given by the HREC (Non-Medical)

I/We fully understand the conditions under which I am/we are authorized to carry out the abovementioned research and I/we guarantee to ensure compliance with these conditions. Should any departure to be contemplated from the research procedure as approved I/we undertake to resubmit the protocol to the Committee. **I agree to completion of a yearly progress report.**

Signature Date

PLEASE QUOTE THE PROTOCOL NUMBER ON ALL ENQUIRIES

Figure 17: Showing the ethical clearance certificate.

Appendix B

Questionnaire Process

B-1 Introduction

The purpose of this document is to provide the survey that was used for the focus group sampling.

B-2 Consent Form for the Questionnaire

The purpose of the consent form is to obtain permission from the participant that they agree to participate in the study, that they understand the purpose of the study and understand that their data will be used as part of the study without revealing their identity. Further, the second part of this consent form also gives the participant the opportunity to consent to whether they would like to take part in the focus group part of the study. This does not mean that they will automatically be a part of the focus group sample, however it means that they are put into group which wish to be a part of the focus group sample.

School of Electrical and Information Engineering

University of the Witwatersrand, Johannesburg

Determining the Predictors for Success in Engineering Studies
Participant Consent Form: Questionnaire

1. I have read the participant information sheet for this study and I understand the purpose of the study.
2. I understand that I may ask questions about the study at any time.
3. I wish to participate in the study
   a. I consent to filling out the survey for this study; and
   b. I consent to be asked questions in a focus group environment for the study if I am chosen to be part of a focus group (**Please circle either Yes or No in the checkbox beside this point)**.

   Yes No
4. I understand that I am free to leave out any questions in the Questionnaire.
5. I understand that I may stop the Questionnaire at any time and withdraw from the study.
6. I understand that my name or identity will not be used in any research reports, publications or theses that result from this research.

Participant's name and surname: …….

Participant's student number: …….

Participant's signature: ……

Participant's contact details:

……

……

Researcher's name: Alessandra Chiara Maraschin
Researcher's signature: ……..

Researcher's email address: Alessandra.Maraschin@students.wits.ac.za

Supervisor's name: Professor Estelle Trengove
Supervisor's email address:

B-3 Questionnaire for Focus Group Sampling

Determining the Predictors for Success in Engineering Studies

Student Number: _____

Age: _____

Year of Study: _____

1) **What language were you taught in during high school?**

   (Grade 8- Grade 12)?

English	**Afrikaans**	**Zulu**	**Xhosa**	**Other (specify)**

2) **Do you have financial aid, a scholarship or a bursary to study at university?**

Yes	**No**

3) **Do you live in university residence?**

Yes	**No**

4) **If you answered NO to question 3): How far do you travel to get to university every day?**

Travel Duration to university (minutes): _____

Travel Distance to university (kilometres): _____

Appendix C

Focus Group Questions

C-1 Introduction

The purpose of this document is to provide the main questions and themes explored in the focus group sessions.

C-2 Focus Group Questions/Topics

In each focus group, the following questions and topics were posed to the participants:

- Why did you choose engineering?
- Do you live at University or in off campus accommodation?
- How do you study?
- Do you have access to a computer and internet facilities (prior to university and currently)
- Could you describe your support structure?
- Let's discuss academic support
- How do you spend your time, i.e. hours spent studying, socialising and doing other activities?
- What was your language medium at school?
- Do you have financial aid and how do you feel about it?