FACTORS AFFECTING FEMALE STUDENTS STUDYING ENGINEERING AT A HIGHER EDUCATION INSTITUTION

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DECLARATION

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TITLE OF PROJECT: Factors Affecting Female Students Studying Engineering at a Higher Education Institution

DECLARATION:

In accordance with Rule G4.6.3, I hereby declare that the above-mentioned treatise/ dissertation/ thesis is my own work and that it has not previously been submitted for assessment to another University or for another qualification.

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ABSTRACT

Engineering is of vital importance for humankind. Engineering combines the fields of mathematics and science, including engineering science and technology, in order to solve problems in the real world and in order to improve the society and economies of countries. It includes the ability to implement ideas in a cost effective and practical manner. Some of these solutions may include sustainability, needs of society, necessary risks and protection of the environment. Engineers develop ideas by using production of technology in order to improve the living of humankind. This includes designing and manufacturing different products based on customer needs and expectations.

Although a field in engineering is largely a male-dominated career, women are becoming more interested in this career, compared to a few years ago. The problem remains that female students are still in the minority compared to their male counterparts studying engineering. Therefore, universities need to find solutions to attract female students towards engineering. There are various reasons why female students choose to study engineering, which include different influences, encouragements and their perception towards the Faculty and the academic staff. Thus, the purpose of the research study is to identify the reasons for both genders, currently studying engineering at Nelson Mandela University, formally known as Nelson Mandela Metropolitan University (NMMU), why they chose to study engineering, what influenced their studies, their encouragements or discouragements and overall perception and experience while studying engineering. The main focus will be on female students.

This research study was an exploratory, mixed method study, which contains literature studies, surveys and cross-sectional studies. A literature study was compiled by using secondary sources in order to identify the importance of engineering internationally and within South Africa, women in the workplace and female students studying towards engineering. The empirical study, which consisted of a survey, was compiled and distributed to all Nelson Mandela University undergraduate students studying towards an engineering qualification. Respondents were asked various questions regarding pre-studies and their perceptions and experiences during their studies. This includes their experience with the academic staff and the Faculty of Engineering in general. For the analysis of the data, both Descriptive and Inferential Statistical methods were used.

Some of the findings from the research study include that both genders develop an interest for engineering at a young age (between ages 13 – 18). Therefore, an interest is developed

during high school level. Both genders choose to study engineering for the same reasons. The interest for choosing a career for both genders was triggered by a qualified engineer's influence. During high school, female students take part in science, mathematics and engineering programmes and participate in competitions or contests. Both gender's science, mathematics and engineering abilities increased since they started their studies at a higher education institution. From the findings, both genders indicated that they have a high level of interest in engineering, they are satisfied with their choice of engineering field and they are committed to complete their engineering qualification. Both genders are confident that they will find employment in engineering that pays well. Female students believe that they are better at problem solving activities, they are more committed to their studies, they work better with other people and they are more confident in their engineering abilities compared to the male counterparts.

The findings also include that during their studies, both genders receive encouragement from various factors, but the significant source of encouragement for both genders are their mothers and employment opportunities. Whereas the most significant source of discouragement for both genders are their grades or academic performance and the amount of time required for engineering. Both genders receive equal quality in lecturing throughout their studies and the academic staff do not treat female students different from male students. It is also significant that female students receive support from the Faculty of Engineering. Female students will definitely encourage other females to study towards a field in engineering and find the academic staff approachable. Academic staff does give regular feedback to students regarding their academic performance. Therefore both genders know at all-time their academic performance and therefore will be able to improve their results. There are not enough female lecturers within the Engineering Department. Female lecturers serve as role models for female students. Therefore, the University's management team needs to investigate this matter.

The research study concluded with recommendations and considerations, contribution towards the body of knowledge, future research and the limitations of the study. Furthermore, the study offers an understanding of engineering students at Nelson Mandela University, which includes their current overall experience during their studies. The treatise will therefore assist the readers and especially Nelson Mandela University to attract and retain female students by addressing their challenges they experience during their studies.

Keywords: Women, Engineering, Gender, Higher Education.

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LIST OF ACRONYMS AND ABBREVIATIONS

Acronyms & Abbreviations	Terms in full
DHET	Department of Higher Education and Training
ECSA	Engineering Council of South Africa
HEI	Higher Education Institutions
NMMU	Nelson Mandela Metropolitan University
NMU	Nelson Mandela University
OECD	Organisation for Economic Co-operation and Development
REC-H	Research Ethics Committee – Human
RO	Research Objective
RQ	Research Question
URL	Universal Resource Link

Table A.1: List of acronyms and abbreviations.

Chapter 1

1. INTRODUCTION

1.1. Background

Engineering has become an attractive field of study, compared to a few years ago (Kossiakoff et al., 2011). According to the Engineering Council of South Africa (2015), also known as ECSA, engineering combines the fields of mathematics and science, including engineering science and technology, in order to solve problems in reality and in order to improve the society and economy of the country (ECSA, 2015). In addition, engineering includes the ability to implement ideas in a cost effective and practical manner. Some of these solutions may include the sustainability, needs of society, necessary risks and protection of the environment (ECSA, 2015; Kossiakoff et al., 2011). They develop ideas by using production of technology to improve the living of humankind (Harris et al, 2009), by designing and manufacturing different products based on customer needs and expectations (Lui et al., 2014).

Engineering offers a wide variety of fields to choose from (Queen's University, 2016). Each field has a unique purpose in the world, in order to increase a country's way of living, economic growth, sustainability and needs of the society (Kossiakoff et al., 2011; Queen's University, 2016).

Although engineering is a popular field to enter, there is a major shortage of engineers all over the world and South Africa, especially has a critical need for quality engineers. Therefore, it is very important for young engineers to receive the relevant knowledge and skills, in order to improve the society and present solutions to improve the South African economy (ECSA, 2015). South Africa is in need of both males and females to enter the field of engineering (Hunt, 2015). Engineering is labelled as a male dominant, objective and impersonal field of study (Stonyer, 2002) and thus women receive less encouragement than men do in order to enter a field in engineering (Hunt, 2015). The biggest challenge remains to attract and retain women towards a field in engineering (Barkhuizen & Du Plessis, 2015).

As soon as female students enter the university environment, they are already at a disadvantage due to gender inequality (Stonyer, 2002). There could be many reasons why females distance themselves from male-dominant careers, for example social influences, past experiences or even a female's own perception about certain fields (Bodner et al.,

2006). In addition, male and female students receive the same quality training, which includes knowledge, skills and experience. Thus, females are consequently equally equipped as their male counterparts (Perez, 2011). Therefore, it is the universities' responsibility to assist these female students to cope with the working environment and support them with ongoing outreach programmes (Mills, 2011). In addition, it is also the universities' responsibility to teach students how to make a difference in the workplace. Problem based learning projects should be included in the curriculum, which could equip students to handle relevant business problems. Undergraduates should have a sound foundation of the following competencies with regard to their thinking processes, namely effective working with other individuals, excellent problem solving skills, business understanding and planning, financial modelling, risk and opportunity analysis, sustainable development (Bhamidimarri & Liu, 2016; Perez, 2011), different development processes and communication to achieve outcomes (Bhamidimarri & Liu, 2016). Thus, it concludes that education is the best investment any country can make for their future prospects (Burke & Mattis, 2007).

However, the biggest challenge for these female graduates is when entering the full-time workforce. They are confronted with realities in order to improve the society. Thus, it is very important for universities to equip these female students with the necessary skills and knowledge that are needed for high productivity and performance. These graduates must also be equipped to manage potential disappointments in their career, which could also be expectations that are not met (Baytiyeh & Naja, 2012). In order for females to make it work at the workplace, they need to love what they are doing. In addition, key character traits must include dedication, drive and courage. These character traits are essential to be successful in this industry. If those traits can be combined with flexibility and excellent people skills, then it can bring great value to the engineering profession (Schäfer, 2006).

The purpose of this research study is to provide the reason why female students choose to study engineering. This includes different factors affecting female students while studying towards a field in engineering at a Higher Education Institution. This will assist Nelson Mandela University students, previously known as Nelson Mandela Metropolitan University (NMMU) to identify these challenges that female students encounter. Therefore, the university can implement platforms in order to assist female students, as well as how to attract and retain them.

The following section of this chapter will focus on the problem statement of this research study. This will be followed by the Research Objectives (RO_X), Research Questions (RQ_X) and scope and delimitation. The significance of the research study is discussed, followed by the research paradigm, research design and methodology used. The process of ethics clearance received for this study is discussed. This chapter concludes with a graphical overview of the structure of this treatise. See Figure 1.1 for the structural overview of Chapter 1.

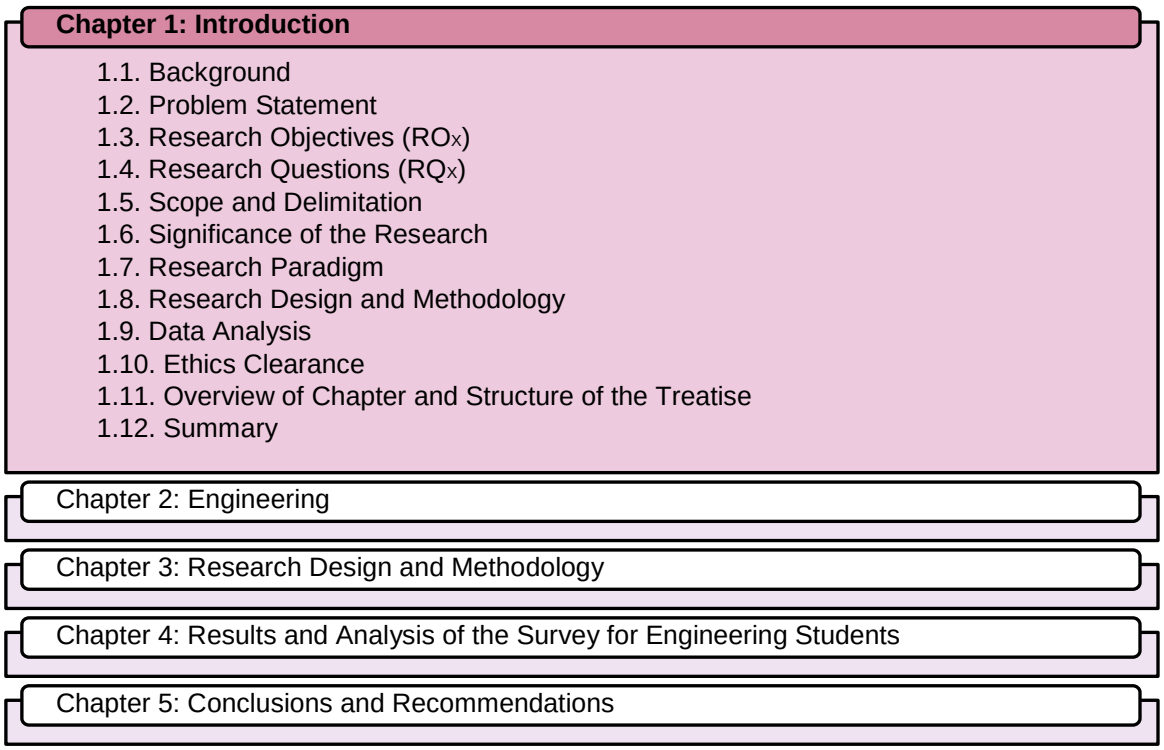

Figure 1.1: Structural overview of Chapter 1.

1.2. Problem Statement

As discussed in the previous section, there are very few females entering into the engineering workforce compared to their male counterparts. Therefore, it should be analysed why there are so few females choosing to study engineering and what attracts females to engineering. There are also many females leaving engineering for different reasons, therefore a problem is how to retain them (Barkhuizen & Du Plessis, 2015).

South Africa has a major shortage of both males and females entering engineering. Engineering is very important in order to improve the society and economy of the country (ECSA, 2015). In the Faculty of Engineering at Nelson Mandela University, in 2012 only 339 females registered compared to 1699 males; in 2013 only 449 females compared to 1699

males; in 2014 only 444 females compared to 1701 males; in 2015 only 402 females compared to 1560 males; and in 2016 only 357 females compared to 1448 males. This clearly indicates the low numbers of females entering into engineering, resulting in a major shortage.

Due to engineering being a male-dominant field of study, it is the universities' responsibility to assist female students to address and overcome the different problems they encounter while studying engineering. As mentioned before, females are already at a disadvantage due to gender inequality, when entering the university environment (Stonyer, 2002). Therefore, universities need to assist female students with how to cope when entering the workplace. Thus, it will result in breaking the stereotype and more equality within the different industries.

The main problem to be addressed in this research study is to determine the reason why there is a shortage of women choosing a field in engineering and thus what attracts women towards engineering.

1.3. Research Objectives (RO_x)

The Main Research Objective (RO_M) of this study is as follows:

RO_M - To determine the factors that affect female students studying towards a field in Engineering at a Higher Education Institution.

In order to achieve the Main Research Objective, the following secondary objectives need to be achieved first:

RO_1 - *Identify why males and females choose a career in Engineering;*

RO_2 - *Identify the challenges that female students encounter while studying engineering;*

RO_3 - *Identify the research methodology applied in this research study;*

RO_4 - *Identify the significant differences between male and female students for choosing a career in engineering; and*

RO_5 - *Identify the challenges that female students encounter while studying engineering.*

1.4. Research Questions (RQ_X)

Based on the Main Research Objective (RO_M), the Main Research Question (RQ_M) was formulated and is stated as follows:

RQ_M - *What attracts female students studying towards a field in Engineering?*

The following research questions need to be answered, in order to analyse the main research problem effectively:

RQ_1 - *Why do male and female students choose a career in engineering?*

RQ_2 - *What challenges do female students encounter while studying engineering?*

RQ_3 - *What research methodology can be used for this study?*

RQ_4 - *What are the significant differences between male and female students for choosing a career in engineering?*

RQ_5 - *What are the challenges that female students encounter while studying engineering?*

The Research Questions (RQ_X), Research Objective (RO_X) and the various chapters in which they are addressed are linked in order to simplify the research storyline, as illustrated in Table 1.1.

Research Questions (RQ_X)	Research Objectives (RO_X)	Chapters
RQ_1 - *Why do male and female students choose a career in engineering?*	**RO_1** - Identify why males and females choose a career in Engineering	**Chapter 2 ENGINEERING**
RQ_2 - *What challenges do female students encounter while studying engineering?*	**RO_2** - Identify the challenges that female students encounter while studying Engineering.	

RQ_3 - *What research methodology can be used for this study?*	**RO_3** - Identify the research methodology applied in this research study.	**Chapter 3 - RESEARCH DESIGN AND METHODOLOGY**
RQ_4 - *What are the significant differences between male and female students for choosing a career in engineering?* **RQ_5 - *What are the challenges that female students encounter while studying engineering?***	**RO_4** - Identify the significant differences between males and female students for choosing a career in Engineering. **RO_5** - Identify the challenges that female students encounter while studying engineering.	**Chapter 4 - RESULTS AND ANALYSIS OF THE FACULTY OF ENGINEERING SURVEY**
RQ_M - *What attracts female students studying towards a field in Engineering?*	**RO_M**	**Chapter 5 - FINDINGS, RECOMMENDATIONS AND CONCLUSIONS**

Table 1.1: Research Questions (RQ_X), Research Objectives (RO_X) and Chapter Outline.

See Appendix A – Research Alignment Plan for the full alignment plan for this research study.

1.5. Scope and Delimitation

This treatise will be limited to the Faculty of Engineering students studying an undergraduate qualification at Nelson Mandela University, located in Port Elizabeth, Eastern Cape. Therefore, other universities are not part of this study. Due to the small sample size, it could be a limitation of this study. The scope of this study will be focused on the reason why females choose to enter into a field of engineering, as well as the problems they encounter while studying. This will be sourced through questionnaires answered by both male and female students, but the main focus for this research study will remain on female students.

1.6. Significance of the Research

As mentioned before, a career in Engineering is very important, especially for developing the economy of the country. South Africa needs competent engineers, both males and females.

Although engineering is becoming a more attractive field of study, there are many challenges, especially for female students. This study will address these challenges. The importance of engineers and the influence they have on the South African economy will briefly be highlighted in this study.

If the challenges for female students studying in an engineering field can be addressed, then more female students will complete their studies in engineering. This will result in a larger number of females entering the pool of engineers. Thus, the quality and the productivity will increase towards improving the stand of living as well as the society's needs (Burke & Mattis, 2007).

Universities will be able to identify and address the challenges which female students encounter and implement programmes, which will assist them through their studies. Thus, universities will have to attract female students in order to choose a field in engineering, as well as to retain them.

This study compares males and females' perception in the factors that influenced them in choosing to study towards a field in engineering. It will also be possible to compare their achievement goals.

1.7. Research Paradigm

According to Collis and Hussey (2014), a research paradigm is the philosophical framework that guides researchers on how their scientific research should be conducted (Collis & Hussey, 2014). Research philosophy is the researcher's assumption and personal views of the world that constitute acceptable knowledge. It forms a foundation for the research strategy and research methodology around these assumptions. If the researcher is concerned about observational phenomena, then the research study will differ from the researcher who is concerned with the understanding of subjective meanings of feelings and attitudes of certain people. Their choice of research strategy and research methodology will differ considerably. The research paradigm is divided into three major ways of thinking, namely positivism, interpretivism and realism (Collis & Hussey, 2014; Saunders, et al., 2012).

For the purpose of this research study, the positivist way of thinking will be adopted. Positivism is a philosophical system that recognises that which can be verified scientifically or capable of mathematical or logical evidence. The researcher uses the systematic

methods that involve observation and experiment. A deductive logic or approach will be applied in this study (Collis & Hussey, 2014). In addition, it emphasises empirical data and scientific methods. The researcher can collect knowledge about the real world by observing it. This way of thinking allows the researcher to investigate social reality to have no effect on the environment being examined (Collis & Hussey, 2014; Creswell, 2014). The focus will mainly be on existing theory to develop hypotheses. The hypotheses will be tested and result in accepted or not accepted (Saunders, et al., 2012).

The following section discusses the research design and methodology used to conduct the research for this treatise.

1.8. Research Design and Methodology

The following section will elaborate on the research design and methodology that are used for this treatise. It will then be divided into sub-sections, which will include the literature study, data collection, sample and data analysis.

1.8.1. Research Design

For the purpose of this study, a mixed method research approach is used. Both ends of the paradigm continuum are incorporated, which are quantitative and qualitative approaches (Brannan, 2005). Therefore, the collection of the data involves both quantitative and qualitative data, integrating these approaches with one another and then using distinct designs that may involve philosophical assumptions and theoretical frameworks. A complete understanding of the research problem will therefore be realised, which is not possible by using each approach in isolation (Creswell, 2008).

The researcher aims to gain insight into the experience and knowledge of the individuals in the given research problem. The data collected would be used in order to assist the researcher in analysing and interpreting the meanings derived from the data. This will result in a better understanding of the reality of the research problem.

1.8.1.1. Literature Study

The purpose of a literature study is to analyse methodologies used in previous studies, in order to gain insight regarding the subject matter. Therefore, the strengths, weaknesses and significance conducted in previous studies, provide the researcher with great insight and knowledge in the field of study. This strengthens the existing body of knowledge (Hofstee, 2006). The literature study also identifies new approaches, ideas and perspectives that

have not occurred to the researcher (Leedy & Omrod, 2010). A sophisticated and thorough literature review lays a foundation for a respected research study that is able to increase collective understanding as well as to contribute to the existing body of knowledge (Leedy & Omrod, 2010; Mcniff & Whitehead, 2010).

Leedy and Omrod (2010) emphasise that it is very important to use keywords or phrases when searching for literature, as it is a summary of the topic being researched. Therefore, keywords can find potential relevant resources. The ability to review research of others and to evaluate the quality of their methods, results and conclusions is an important skill for any researcher. The researcher will improve his or her own research efforts, by developing their ability to evaluate other researcher's publications (Leedy & Omrod, 2010).

For the purpose of this research study, the Nelson Mandela University Library research system will be used to obtain relevant literature. For current online publications, Google Books and Google Scholar will also be used extensively. Although hardcopy textbooks will be used for this field of study, the majority of research will also contain online searching of academic and other databases. This could be very useful to find online journal articles and publications. This method has the following advantages:

- *Easy access* – Online material can easily be accessed;
- *Currency and availability* – Publications are readily and available, which is up-to-date, whereas hardcopies take longer before available in the library. Therefore, soft copies are always available;
- *Flexibility* – It allows the researcher to use any keywords which they feel suit the relevant search;
- *Cross-disciplinary search* – Multiple areas can be search with only one search; and
- *Searching speed* – The researcher is able to search through millions of publications within a few seconds and use those that are relevant to the field of study (Collis & Hussey, 2014).

The researcher will commence by reviewing the most recent publications and then move to earlier literature or publications. Important and relevant information will be highlighted in each article. Within the relevant publications, the references and authors will be identified which could result into previous relevant publications, which could be used. The processed literature will be discussed with the researcher's supervisor for input and approval. The following sub-section will discuss the research methodology for this study.

1.8.2. Research Methodology

The following sub-section will focus on how data will be collected and analysed. This will include the sample and questionnaire distribution.

1.8.2.1. Data Collection

One of the most common methods for collecting primary data from samples through direct questioning of respondents is surveys. Surveys can be highly structured questionnaires from Internet self-completion questionnaires, to unstructured questionnaires such as face-to-face or telephonic interviews (Collis & Hussey, 2014; Hofstee, 2006). Questionnaires are a helpful tool in order to structure and record the collection of data, in order to gain insight in the respondent's opinions, ideas, desires, attitudes and values (Kumar, 2011; Wegner, 2012). The results are then analysed and generalised to the population of the study (Collis & Hussey, 2014).

For the purpose of this research study, an electronic questionnaire will be used as a form of structured interviewing to collect the data. This will allow all respondents to answer the same questions in the same format (Krippendorff, 2012).

The respondents are students at Nelson Mandela University, who are registered for an engineering related qualification in 2016. This includes all undergraduate students registered in the School of Engineering, namely Civil Engineering, Electrical Engineering, Industrial Engineering, Mechanical Engineering and Mechatronics. All respondents are required to provide feedback and their opinions on the same questions. The questionnaire will include a demographic section as well as sections covering their experience while studying towards a field in engineering. Information obtained from the literature studies will be used to strengthen the foundation of the questions used in this questionnaire.

A distribution list will be compiled which contains all possible respondents to participate in this study. An email with a Universal Resource Link (URL) to the survey will then be sent to participants on the distribution list. After completion of survey, it will automatically be returned to the researcher. Confidentiality and anonymity of the participants will be preserved and no names will be mentioned in this study. In total 1 716 emails will be sent out to potential respondents.

The purpose of the questionnaire will therefore be to collect relevant data on the experience of both male and female students. These respondents will be asked to identify the different

reasons why they (male and female students) chose a career in engineering and this will include the challenges they face while studying engineering. Therefore, the survey will assist the researcher to gain insight into the different factors that affect female students while studying towards a field of engineering at Nelson Mandela University.

1.8.3. Sample

For the purpose of this study, the population is all undergraduate Nelson Mandela University students registered in the School of Engineering. Therefore, they are identified as potential respondents to participate in this study. Sampling is a subset of data value derived from the population, also known as sample. A sample is used when it is not possible to record every data value from the entire population, mainly due to time, cost and possible destruction of the object being measured or observed (Wegner, 2012). For the purpose of this study, a non-probability sampling method was incorporated by means of convenience sampling and probability sampling such as simple random sampling, because the researcher has convenient accessibility to the respondents and each group has an equal chance of being selected (Kumar, 2011; Wegner, 2012). In total, there are 1 716 potential respondents.

The survey will require all currently enrolled undergraduate Engineering students to complete the survey. Therefore, in order for respondents to qualify to participate in the survey, the preconditions are that they must be a student at Nelson Mandela University and currently enrolled for any undergraduate engineering qualification. Through means of a compiled distribution list, an email will be send out which contained a link to the survey. This email will be send to all undergraduate Engineering students.

The following sub-sections will elaborate on the Nelson Mandela University Engineering students and the questionnaire distribution.

1.8.3.1. Nelson Mandela University Engineering Students

The Nelson Mandela University population group consists of 1 716 registered undergraduate students in the School of Engineering. From this total, 1 377 are the registered male students and 339 are the registered female students. It is therefore clear that all Nelson Mandela University undergraduate engineering students qualify for this research study and would consequently be invited to participate.

Both male and female students will be used for this study, so that a comparison between these genders can be conducted on choosing a study field in engineering. The main focus

will still remain on the female students and what problems they encounter while studying engineering.

1.8.3.2. Questionnaire Distribution

Primary data will be used in this study for the data collected, as it did not exist prior to this research being conducted. The survey will be created by using the Nelson Mandela University survey tool. It is known as a professional toolkit in order to create surveys. Once completed, the survey will be sent to all participants. The respondents are students at Nelson Mandela University, who are currently registered in 2016 for an undergraduate engineering related qualification. This will include all undergraduate students registered in the School of Engineering, namely Civil Engineering, Electrical Engineering, Industrial Engineering, Mechanical Engineering and Mechatronics. All respondents will be required to provide feedback and their opinions on the same questions.

As mentioned above, a distribution list will be compiled. An email with a URL to access the survey will be sent to all participants on this list, which will be made available to all possible respondents to participate in this study. After completion of survey, it will automatically be returned to the researcher. Confidentiality and anonymity of the participants will be preserved and no names will be mentioned in this study. In total 1 716 emails will be sent out to potential respondents.

1.9. Data Analysis

Due to using the online survey service, the responses or data will automatically be tabulated, by using the export function of the tool, into Microsoft Excel format, which will ease the analysis process. The data would be analysed and any corrupt or incomplete records will be removed from the datasheet. One of the statisticians at Nelson Mandela University will analyse the data. Descriptive and Inferential Statistical methods will be used to analyse the collected data and to draw conclusions. Descriptive statistics includes the measurement of central tendency, such as mean, median and mode and inferential statistics include specific measurement of association such as the Chi-Square analysis. In addition, the reliability of the instruments will be calculated by using Cronbach alphas.

1.10. Ethics Clearance

Full ethics clearance will be obtained from the Nelson Mandela University Business School through the Research Ethics Committee – Human (REC-H). The accepted ethical clearance

form is attached in Appendix B – Ethical Clearance Form E with Resolution Number: H16-BES-BUS-022.

1.11. Overview of Chapters and Structure of the Treatise

The layout of the treatise chapters, RO_s and RQ_s can be seen in Figure 1.3. The treatise will flow as follows:

1.11.1. Chapter 1: Introduction

Chapter 1 provides an introduction with the significance and importance of engineers and especially female engineers. This resulted in the problem statement to be identified, along with the research questions and research objectives. The purpose of this chapter indicates a holistic overview of what is expected in this treatise.

1.11.2. Chapter 2: Students in Engineering

The purpose of Chapter 2 is to address research questions RQ_1, stating "Why do male and female students choose a career in engineering?", and RQ_2, stating "What challenges do female students encounter while studying engineering?". A literature review is performed by reviewing current literature studies regarding these specific research topics.

1.11.3. Chapter 3: Research Design and Methodology

Chapter 3 will discuss the research methodology used for this treatise, which includes the research paradigm, sampling design and measuring instruments used. Therefore, the purpose of this chapter is to address research question RQ_3, stating "What research methodology can be used for this study?".

1.11.4. Chapter 4: Results and Analysis of the Engineering Survey

Chapter 4 will identify and discuss the results of the empirical data that was collected. Therefore, the purpose of this chapter is to address research question RQ_4, stating "What are the significant differences between male and female students for choosing a career in engineering?", and RQ_5, stating "What are the challenges that female students encounter while studying engineering?".

1.11.5. Chapter 5: Conclusions and Recommendations

Chapter 5 will provide a summary of the research study and offer recommendations based on the findings. Therefore, the purpose of this chapter is to address research question RQ_M, stating "What are the effective attractions of female students studying towards a field in Engineering?". This chapter will also conclude by mentioning possibilities for future research and identifying limitations of this study.

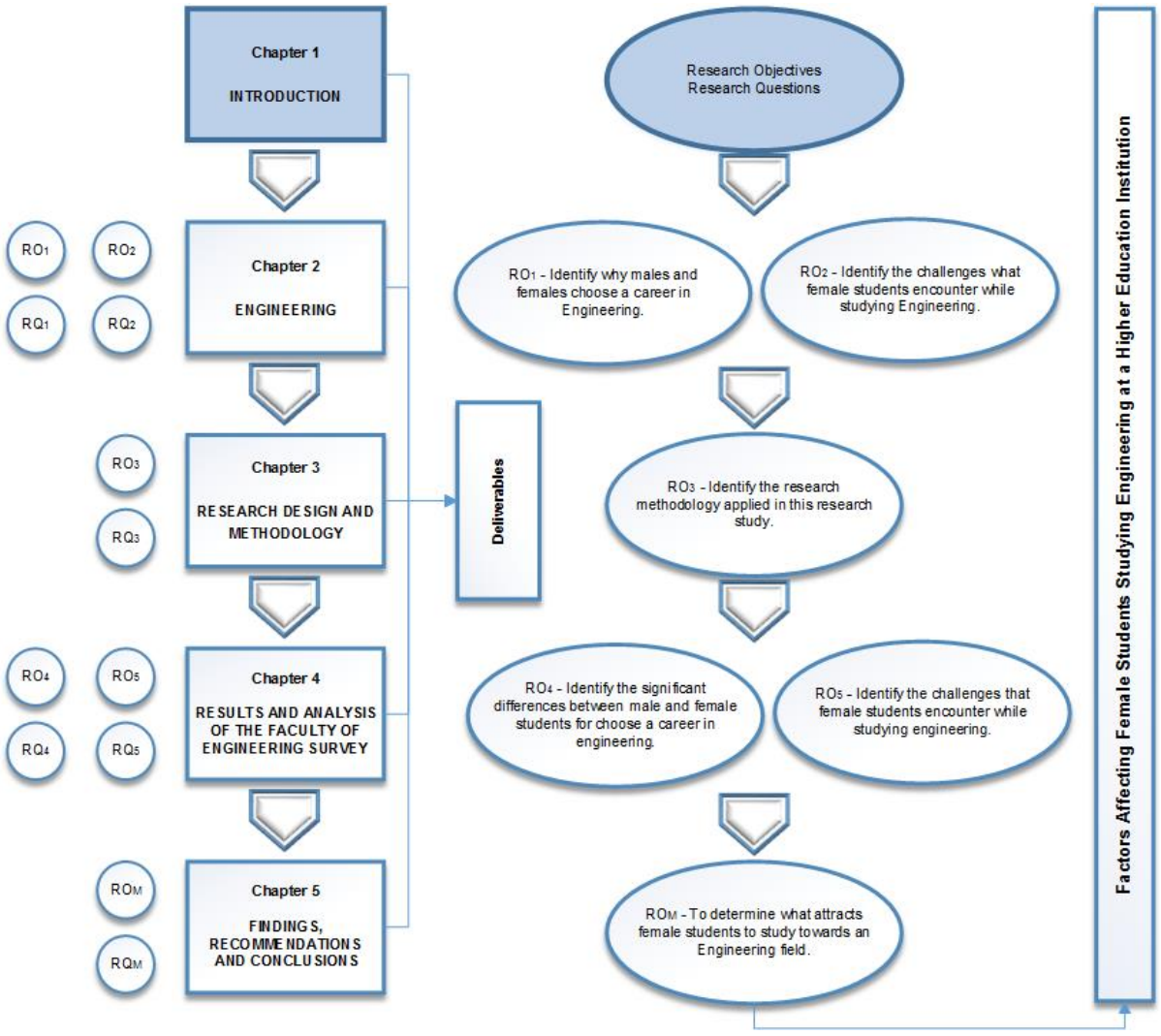

Figure 1.2: Preliminary layout of the Treatise.

1.12. Summary

The researcher provided a brief background to the importance of engineering. South Africa especially has a major shortage of both male and female engineers. Being a male-dominant field, female engineers are already at a disadvantage and need a lot of encouragement to

remain in the field of engineering. The problem statement was identified, followed by a discussion on the research paradigm, research design, methodology and data analysis used in this research study. Therefore, this chapter indicates a holistic overview of what is expected in this treatise.

Chapter 2 will provide a literature review by revising current literature studies regarding these specific research topics. This chapter will address the research questions, RQ_1, which states "Why do male and female students choose a career in engineering?" and RQ_2, which states "What challenges do female students encounter while studying engineering?". Therefore, this chapter will focus on the research objectives, namely which is to identify why males and females choose a career in Engineering (RO_1) and to identify the challenges that female students encounter while studying Engineering (RO_2).

Chapter 2

2. ENGINEERING

2.1. Introduction

Chapter 1 presented an outline of the treatise by discussing the background to this research study and the research problem. The problem statement was linked to the research questions and research objectives, which must be investigated to ensure that the problem is adequately addressed. Chapter 1 briefly discussed the research methodology that is used for the study to ensure it is deemed reliable and valid in the research community.

Chapter 2 is completed by means of reviewing current literature in the respective field of study. This will assist the researcher with current knowledge in the respective field of study. Therefore, potential weaknesses, especially in previous research and in this study are removed. In addition, the literature review will provide a contextual view within which the research study is placed.

This chapter will address RQ_1 which states "*Why do male and female students choose a career in Engineering?"* and RQ_2 which states "*What challenges do female students encounter while studying engineering?*". The research objectives of this chapter are to identify why males and females choose a career in Engineering (RO_1) and to identify the challenges that female students encounter while studying Engineering (RO_2). In order to find a suitable answer to the identified research question, current literature studies are reviewed. See Figure 2.1 for an overview of the research question and research objective of this chapter.

Chapter 2 reviews the role of engineering internationally. Thereafter, focus is placed on engineering within South Africa. Furthermore, women in the workplace and women in engineering are highlighted briefly. Chapter 2 continues by discussing female students studying towards a career in engineering. Figure 2.2 provides a structural overview of Chapter 2.

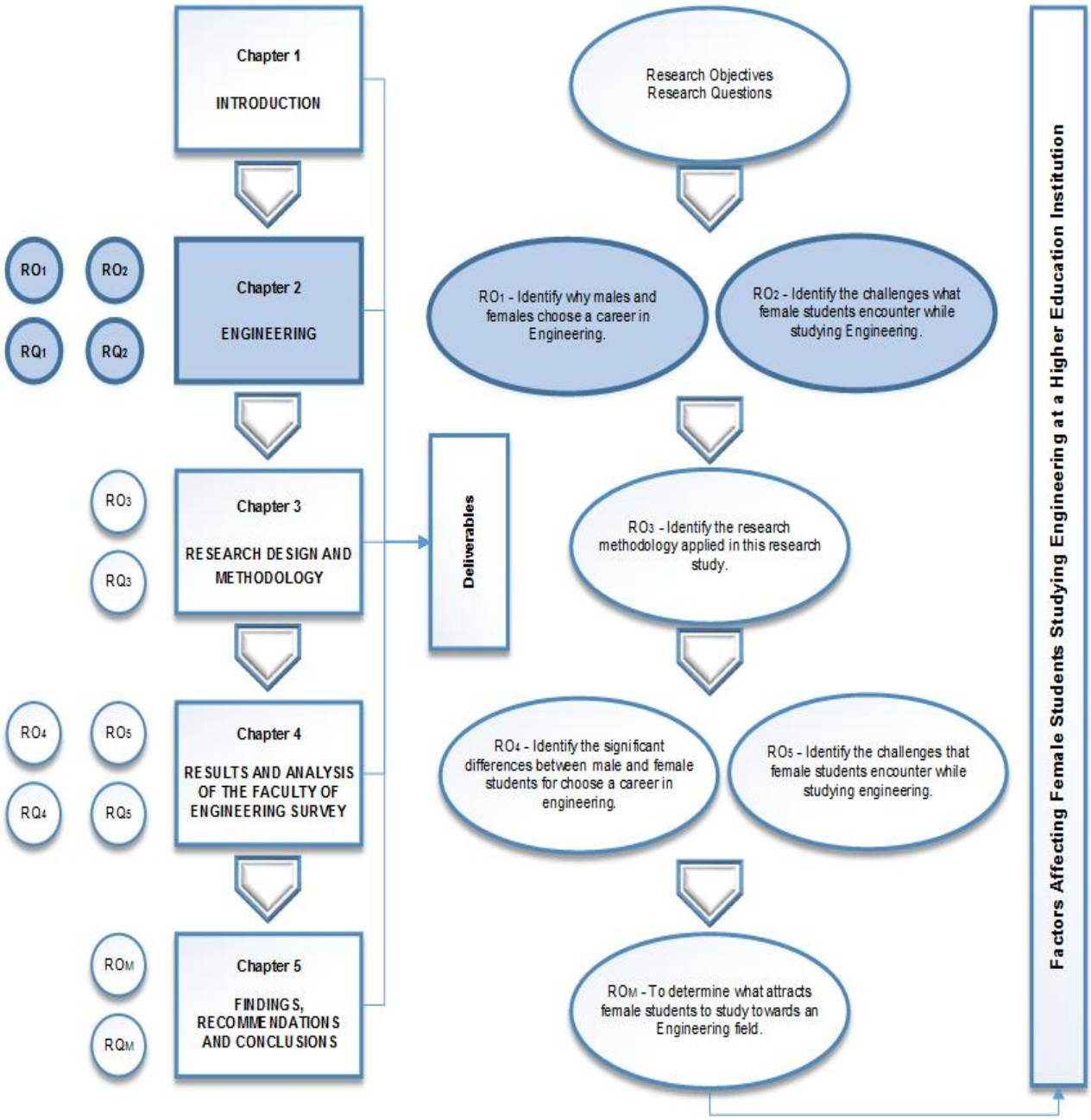

Figure 2.1: Overview of Chapter 2's Research Objectives.

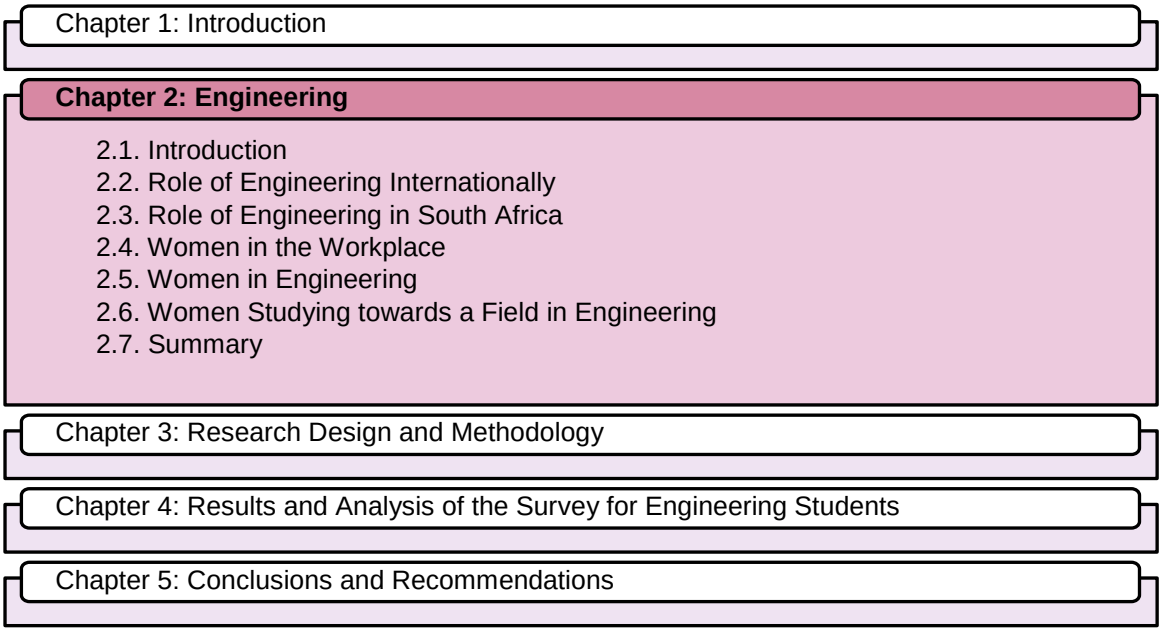

Figure 2.2: Structural overview of Chapter 2.

2.2. Role of Engineering Internationally

Engineering has been part of the world for a very long time. Engineering was there when man invented the wheel, which was before science. Inventions like these in history pushed human beings towards technology and inventing new discoveries. Due to engineering and science, human beings can enjoy a comfortable life (Male et al., 2009). Therefore, there is constantly an increasing demand for skilled engineers in the world (Johnson et al., 2013).

Engineering has become an attractive field of study compared to ten years ago. According to the Engineering Council of South Africa (2015), also known as ECSA, Engineering combines the fields of mathematics and science, including engineering science and technology, in order to solve problems in the world and in order to improve the society and economy of the country (ECSA, 2015). Therefore, it is very important for young engineers to receive the relevant knowledge and skills, in order to improve society and find solutions to improve their country's economy (Male et al., 2009). This includes the ability to implement ideas in a cost effective and practical manner. Some of these solutions may include the sustainability, needs of society, necessary risks, protection of the environment (ECSA, 2015) and improving the efficient use of resources (Bell, 2011). All of these need to comply with the appropriate legislation, to ensure that every project is completed in an ethical manner (ECSA, 2015; Harris et al., 2009).

The purpose of engineering and even other technological sciences is very important for both past and future economic performance (Male et al., 2009). Without the appropriate people in these careers, the economic success, securities and scientific leadership will decrease. Therefore, careers in engineering, science and mathematics contribute to the standard of living and quality of the country's life. These careers also affect a country's health, prosperity and security. Thus, it can be concluded that education in the engineering field is the best investment any country can make for their future prospects (Burke & Mattis, 2007; Male et al., 2009). In addition, Bell (2011) elaborates on the important role of engineers, as engineers develop new infrastructure systems that acknowledge the relationships between changing society and technology, by shaping demand for resources and intervening between clients, values of society, the environment and new possibilities of technology (Bell, 2011). Thus, innovative advances in the field of engineering will improve the way of living, promote economic growth and protect national security (Allen & Zhang, 2016; Alwi et al., 2014).

According to Queen's University (2016), there are many different fields within engineering. Each field has a unique purpose in the world, in order to increase a country's way of living, economic growth, etc. These different fields are elaborated on below:

- *Aeronautical and aerospace engineering* – This field includes designing, manufacturing and operating of aircraft, spacecraft, rockets and missiles. Thus, this type of engineering goes as far back as the Wright Brothers and Leonardo da Vinci. The advantage for using aircrafts as a medium of transport, allows people of any country to easily access other national or international countries. These engineers also assist and develop a sound defense force for a country (Bertin et al., 2004).

- *Agricultural engineering* – This field includes engineers who apply technology and biological science to agriculture, as well as the designing of agricultural machinery and equipment. In addition, these engineers develop ways to conserve soil and water in such a manner to discover different ways to improve the processing of agricultural products (EnvironmentalScience, 2016). Therefore, these engineers help to make farming sustainable, safe and environmentally friendly. New technologies and methods are developed to improve the use of land and the use of resources. Strategies are also developed to protect the health and safety of the workers, animals and agricultural products (EnvironmentalScience, 2016).

- *Biomedical engineering* – This field includes the application of engineering techniques and principles to the medical field. For example, to combine problem solving skills, design and innovation in order to assist and to improve patient health care and the quality of life of individuals (Bronzino & Enderle, 2012).

- *Biomechanical engineering* – This field includes how engineering is applied to the human body. Engineers design products that provide safety, feel comfortable and enhance human performance. For example, clothing designs, safety car seats for children, running shoes, etc. Therefore, engineers can use their innovation, creativity and knowledge to design and test products (Queen's University, 2016).

- *Chemical engineering* – This field includes the designing of equipment and processes for large-scale chemical manufacturing. Chemical engineers work at a variety of manufacturing industries, such as industries that produce energy, electronics, food, pet food, clothing, paper, etc. In addition, chemical engineers also assist in health care and biotechnology industries (Denn, 2012).

- *Civil engineering* – This field includes engineers who plan, design, construct and maintain a variety of structures, such as bridges, roads, buildings and dams, which result in meeting different human needs (Institution of Civil Engineers, 2015).

- *Computer hardware and software engineering* – This field includes the computer hardware engineers to design, develop, research and test computer hardware. This includes all equipment, such as modems, keyboards and printers (Berry et al., 2003). The computer software engineers apply and address the quick evolving principles and techniques of computer science, engineering and mathematical analysis and skills to the developing, design and testing of software systems (Queen's University, 2016).

- *Electrical engineering* – This field includes engineers who design, develop, test and supervise the manufacture of any electrical or electronic equipment (Laplante, 2005). This will include aspects such as broadcasting and communication systems, electric motors, machinery controls, lighting and wiring in buildings, automobiles, aircraft and radar navigation systems and power generating, controlling and transmission devices (Laplante, 2005).

- *Mechanical engineering* – This field includes everything regarding mechanical devices, for example the designing, building and testing of machines. These could range from small individual devices to large systems (University of Washington, 2014).

- *Mechatronics engineering* – This field includes a combination of mechanical engineering, electronics and computer systems (Bradley et al., 2015). This will include characteristics of mechanical components, electrical sensors, electrical and mechanical actuators and computer controllers into products and systems beneficial to the society. A mechatronic engineer incorporate a combination of mathematics, basic sciences, engineering sciences and engineering design in order to enable application in fields of emerging knowledge (Bradley et al., 2015; De Silva, 2016).

- *Mineral engineering* – This field includes mining, metallurgical and petroleum engineers. Their focus is upon extracting minerals from the ground and converting them to pure and solid forms (Queen's University, 2016).

- *Nuclear engineering* – This field includes research and development of processes, instruments and systems which could benefit radiation and nuclear energy. These engineers also operate nuclear power plants, disposal of nuclear waste, develop nuclear power sources for spacecraft and usage of radioactive materials for medical or industrial uses, for example equipment used to diagnose or treat medical problems (Kok, 2009).

- *Photonics engineering* – This field includes engineers who detect and control photons especially in the visible light spectrum. These inventions provide the infrastructure for the Internet (Queen's University, 2016).

- *Sustainable design engineering* – This field is also known as eco-design, green design or design for the environment. Therefore, this field includes economic, social and ecological sustainability in designing of physical objects. These objects may vary from buildings, cities or even the earth's surface (Davidson et al., 2010). Sustainable design will include urban design, urban planning, graphic design, industrial design, fashion design or interior design (EnvironmentalScience, 2016).

ECSA (2015) elaborates further upon the activities engineers need to do, in order to improve the economic and social needs of the society. These include the design and improvement of components, processes or systems; planning and organisation of the capacity and location

of infrastructure; investigate and report any engineering problems; manage the implementation or construction projects; research and develop products and processes; and train, develop and educate engineering staff (Alwi et al., 2014; ECSA, 2015). Therefore, all the different engineering fields mentioned above, positively contribute towards all countries globally in one way or another. Globalisation makes a difference in organisations, which compete competitively and internationally. Globalisation has its advantages, such as having better access to suppliers and customers around the world, which contributes to a country's economy (Gereffi et al., 2008).

Forbes (2016) made a top ten list of the best jobs to have. Aspects taken into account include income, growth potential in the specific field, the degree of competitiveness and the amount of public contact. The following jobs made the top ten list:

- Actuary;
- Audiologist;
- Biomedical Engineering;
- Computer Systems Analyst.
- Data Scientist;
- Dental Hygienist;
- Mathematician;
- Occupational Therapist;
- Software Engineer; and
- Statistician (Forbes, 2016).

According to Adams (2015), the most popular engineering jobs around the world as listed in Forbes in 2015 are biomedical engineering, petroleum engineering, electrical engineering, computer engineering, civil engineering, mechanical engineering and industrial engineering (Adams, 2015).

From 2010 to 2014, careers in engineering have grown. The top four careers in engineering, which have grown the most, are petroleum engineering (30 percent), mining and geological engineering (12 percent), biomedical engineering (10 percent) and industrial engineering (10 percent). Engineering, as a whole has grown over 7 percent (Wright, 2014). Although jobs in the field of engineering are growing, there is a major problem that most of the engineering employees are older than 55 years. Therefore, most of these engineers will retire within the next ten years. The major challenge will be whether enough students graduating from universities, will join the engineering workforce (Wright, 2014).

Table 2.1 below lists the top ten countries, out of 124 countries, with the most graduates in the engineering and manufacturing field recorded in 2015. During the collection of these statistics, there was not enough data on China and India; therefore, these two countries could not be included. Russia produces almost half a million graduates annually. Countries need to produce over a 100 000 million graduates in order to reach the top ten list (World Economic Forum, 2015). Therefore, a large number of engineers need to enter the workforce, in order to make a difference to their counties.

Top ten countries with the most graduates in engineering and manufacturing	
Russian Federation	454 436
United States	237 826
Iran	233 695
Japan	168 214
Korea	147 858
Indonesia	140 169
Ukraine	130 391
Mexico	113 944
France	104 746
Vietnam	100 390

Table 2.1: Top ten countries with the most graduates in engineering and manufacturing (Adapted from World Economic Forum, 2015)

Although the importance of engineering is considered common knowledge, there is still a major shortage of engineers all over the world. One of the major skills gaps across all engineers who graduated, are leadership. Engineers should show confidence in order to become leaders of tomorrow. They should also be able to create positive change towards the industry and research (Bhamidimarri & Liu, 2016). Engineering and science are constantly evolving. Many of the professions, which will be needed in next 20 years, have not even been invented yet, just as many of the professions which are advertised today did not exist 20 years ago (Dowling, 2015). This includes the spread of mobile technology, developing of composite materials, the increasing demand for energy and many other advances, which have created a variety of fascinating and attractive new professions (Dowling, 2015).

The following sub-section will discuss the role of engineering, with the focus on South Africa.

2.3. Role of Engineering in South Africa

South Africa has a major shortage of qualified engineers. ECSA (2015) indicates that South Africa only has one engineer per 3 166 of the population, whereas other countries like Brazil have 227, Australia has 455 and Chile has 681. The top five most preferred engineering jobs in South Africa are firstly, civil engineering, electrical engineering, software engineering, chemical engineering and mechanical engineering (Oxbridge Academy, 2015). However, according to Thompson (2015), South Africa is urgently in need of electrical engineers, followed by civil engineers and mechanical engineers, as indicated on the government's scarce skills list (Thompson, 2015).

The Department of Higher Education and Training (2016), also known as DHET, in Table 2.2 below, clearly indicates the number of students who enrolled in public Higher Education Institutions (HEIs). Of the 25 public HEIs that enrolled students in South Africa, 11 institutions are regarded as 'traditional' universities, six are Universities of Technologies, previously known as Technikons and six are Comprehensive Universities. In one of the major fields of study, namely Science, Engineering and Technology, it can clearly be seen that from 2012 to 2014, a total of 844 115 students enrolled at these institutions and only 157 598 graduated. The number of graduates therefore only represents 19 percent of the total the total number of students who enrolled during 2012 to 2014. According to Mtshali (2013), there are a number of reasons why students do not complete their studies, namely financial reasons, wrong career path, switching from one institution to the next, lack of academic preparedness and not getting enough support from their universities, to name a few (Mtshali, 2013).

Number of students who enrolled and graduated in public HEIs from the Science, Engineering and Technology field of study		
Year	**Number of Enrolment**	**Number of Graduates**
2012	273 282	48 848
2013	283 622	53 176
2014	287 211	55 574
Total	**844 115**	**157 598**

Table 2.2: Number of Students who Enrolled and Graduated in public HEIs from Science, Engineering and Technology field of study (Adapted from Department of Higher Education and Training, 2016)

Due to the given economic pressures, the potential employers have multi-disciplinary expectations from these graduates. Therefore, the institutions in South Africa need to improve the nature of engineering education. They need to make sure that they deliver young capable engineering graduates, who meet the critical sustainable developmental goals of society (Writer, 2015b), meet the demanding needs of the industry and maintain competitive advantage (Alpay, 2013).

The number of students who enrol at HEIs within the field of science, engineering and technology, will depend on their Mathematics and Physical Science marks, which they receive in High School. Mathematics and Physical Science are one of the admission requirements in order to study in a field of science, engineering and technology. The World Economic Forum (2015) released its 2015 Report, which ranked South Africa at the bottom in the quality of mathematics and physical science education. South Africa ranked last out of 143 countries. Other African countries, which ranked higher than South Africa, are Nigeria, Mozambique and Egypt (World Economic Forum, 2015).

In addition, according to Moodley (2014), in order for South Africa to develop and improve, critical mathematics and scientific skills are required. Due to the lack of these skills, it adds to the lack of beneficiation of mineral resources, which also result in an impact on economic growth (Brunnschweiler, 2008). The challenges associated with the poor quality of mathematics and science education in South Africa can be a result of teachers who are lacking in adequate knowledge of the content and pedagogical knowledge of the content in mathematics and science. Therefore, these also result in low quality teaching (Fortus & Ramnarain, 2013; Moodley, 2014). Therefore, the quality of the matriculants entering

tertiary education, is decreasing and thus universities have to work harder to improve the quality of students finishing their qualifications (Moodley, 2014).

The latest QS World University rankings 2015 report reveals which universities have the best engineering and technology faculties. Out of the 891 universities over the world, the top South African universities are University of Cape Town, which ranked 171 overall and Stellenbosch University ranked 302 overall (Writer, 2015a).

Having a clear picture of the role of engineering internationally and nationally, the following sub-section will focus on gender in the workplace.

2.4. Women in the Workplace

In the past, women had to stay home to look after the children, while men went to work. During the 21st century, a great mind shift occurred where both women and men are seen equally, but not in all professions. In the corporate world, on average women make up 53 percent of entry-level employees, 40 percent of managers, 35 percent of directors, 27 percent of vice-presidents and 24 percent of senior vice-presidents (Harvard Business Review, 2013). Therefore, according to Devillard et al. (2015), because women formulate approximately half of the working age population, if they do not achieve their full potential, this could result in the global economy suffering.

According to McKinsey & Company (2016), men and women are equally ambitious in the workplace, but it is still difficult for women to realise their ambitions. According to a survey that was conducted in the United States of America during 2016, a total of 2 200 random employees were interviewed. Only 67 percent of men and 68 percent of women indicated interest in being promoted to the next level in their jobs. However, only 26 percent of women indicated that gender still plays a major role in the promotion process and 41 percent of them believed that it is more difficult for women to receive a raise or to be promoted (McKinsey & Company, 2016).

Although men and women are becoming equal partners, the gap between them remains large (Devillard et al., 2015). The research of Burke and Major (2014) indicates that the number of women entering the workforce is increasing internationally. There is also some evidence indicating that women in top management positions at certain organisations are more likely to be financially successful. In addition, women in the senior positions are also less likely to take risky decisions (Burke & Major, 2014). However, negative assumptions

about women are made with regard to their commitment and abilities, such as in the workplace; the women's home and family responsibilities; the lack of mentorship and the long hours work environment (Kirton & Healy, 2012).

When viewing every level in the corporate structure, women are still underrepresented. This assumption is made, due to women leaving organisations at higher rates than men do or due to difficulties in balancing work and family (McKinsey & Company, 2015). However, in order for women to succeed in the workplace, they need to love what they are doing. In addition, key character traits must include dedication, drive and courage. These character traits are essential for success in industry. If those traits are combined with flexibility and excellent people skills, they can bring great value to any profession (Schäfer, 2006).

Women encounter greater barriers to advancement and a steeper path to senior leadership in their careers. For organisations to perform at the highest levels, female leadership is vital. Therefore, CEO commitment to gender diversity must be a high priority and organisations need to make a significant and sustained investment to change the organisation's culture and practices in order for women to achieve their full potential (McKinsey & Company, 2015). However, in order for organisations to bridge the gender gap, financial incentives and support; infrastructure and technology; capability building; advocacy and shaping attitudes and laws, regulations and policies are essential (Devillard et al., 2015).

According to Chamie (2014) women are generally more qualified than men, but they are still earning less. More women tend to further their studies to post graduate degrees then men. The Organisation for Economic Co-operation and Development (2015), also known as OECD, conducted a study in 2015 over 36 random countries across Europe and Asia. This study indicated that women between the ages of 25 – 34 earn about 25 percent less than men do. Women are also likely to take on part-time jobs and are less likely to participate actively in the labour market, despite being more qualified than what men are. However, this study also indicted that there are clear gender differences in certain career fields, for example men dominate in the field of science, computing and engineering and women dominate in the field of education and health (OECD, 2015).

The following sub-section will elaborate on women in engineering.

2.5. Women in Engineering

Women have increasingly been entering professions, which were predominately reserved for men. Engineering is a great example where gender inequalities are very slow to change and women engineers are still in the minority (Holth, 2014; Schreuders et al., 2009). However, the South African Government did implement labour laws, for example the Employment Equity Act 55 of 1998, in order to address gender inequality in the workplace (Department of Labour, 2015). Despite these efforts, women engineers are still being outcast or undermined. As mentioned earlier in the study, engineers are important in order to develop a country's economy as well as the sustainability of the country. The attraction and retention of women in this field will maximise innovation, creativity and competitiveness. The biggest challenge remains to attract and retain women towards a field in engineering (Barkhuizen & Du Plessis, 2015). Thus, women leaving the engineering career, most likely experience personal failure (Ihsen, 2005).

Hunt (2015) elaborated that women receive less encouragement than men in order to enter a field in engineering. Women also tend to leave engineering at a higher rate than men, despite working so hard to qualify (Barkhuizen & Du Plessis, 2015; Cadaret et al., 2016) and even achieving better grades than men (Mills, 2011). This may be a result of labour market inefficiency. Most engineering related organisations prevent women from reaching their full potential. This may result in discouraging forward-looking women from entering a field in engineering (Hunt, 2015). In addition, women's disadvantages in the engineering profession originate both from the attributes and priorities of individual women and from organisational cultures and work environments (Cadaret et al., 2016). This has been formulated by the interests, values and philosophies of men. Women are more discouraged in the workplace, due to higher standards of achievement expected from women than from men. Thus, mistakes made by women are judged more severly than men (Ayre & Roberts, 2002).

Barkhuizen and Du Plessis (2015) and Hunt (2015) identified a few factors that women encounter working in a field of engineering. These factors are: balancing long work hours and family; isolation due to being the minority; the lack of mentoring and networks; working in a risk-taking environment; the hostile masculine environment; discrimination; sexual harassment; lack of training and career advancement; salary inequity; and misunderstandings arising from different styles of communication (Ayre & Roberts, 2002; Hunt, 2015). However, in spite of these factors that women are facing, some women are actually successful in these male-dominant careers (Smeding, 2012).

This research gap is very important because females in the engineering workplace are more likely to move or relocate to other organisations. This can be due to unnecessary pressure from the males within the companies. Thus, females need to receive the relevant knowledge and skills when entering the workplace (Franzway et al., 2008). Therefore, companies are constantly facing a lack of qualified female engineers (Ihsen & Buschmeyer, 2007).

Globally about 66 percent of men are interested in engineering, while only 43 percent of women are interested. However, in India, men and women are showing great interest in a career in engineering. In India, 79 percent of women show an interest in engineering, followed with 62 percent of women in China, 55 percent in Brazil, 48 percent in Turkey, 35 percent in United States, 33 percent in Germany, 28 percent in United Kingdom and 27 percent in Japan (Sinha, 2015).

According to ECSA (2015) all engineers in South Africa need to register with ECSA in order to work in one of the respective engineering professions. These categories are: Professional, which includes Professional Engineer, Professional Engineering Technologist, Professional Certified Engineer and Professional Engineering Technician, Candidate, which includes Candidate Engineer, Candidate Engineering Technologist, Candidate Certified Engineer and Candidate Engineering Technician or Specified Categories.

Table 2.3 below indicates the registered numbers under the category Professional, as stated in the Annual ECSA report of 2014/2015. It can clearly be seen that the number of males registered in this category is 25 723, against only 1 619 females. Therefore, females represent only 6 percent of the entire professional registration by gender and category.

Professional Registrations Statistics by Gender & Category		
Category	**Male**	**Female**
Professional Engineer	15 710	713
Professional Engineering Technologist	4 857	299
Professional Certificated Engineer	1 158	7
Professional Engineering Technician	3 998	600
Total	**25 723**	**1 619**

Table 2.3: ECSA – Professional Registrations Statistics by Gender & Category (Adapted from ECSA, 2015)

Table 2.4 below indicates the registered numbers under the category Candidate, as stated in the Annual ECSA report of 2014/2015. It can clearly be seen that the number of males registered in this category is 13 560, against only 3 862 females. Therefore, females represent only 22 percent of the entire candidate registration by gender and category (ECSA, 2015).

Candidate Registrations Statistics by Gender & Category		
Category	**Male**	**Female**
Candidate Engineer	6 320	1 582
Candidate Engineering Technologist	2 770	716
Candidate Certificated Engineer	257	5
Candidate Engineering Technician	4 213	1 559
Total	**13 560**	**3 862**

Table 2.4: ECSA – Candidate Registrations Statistics by Gender & Category (Adapted from ECSA, 2015)

Table 2.5 below indicates the registered numbers under the category Specified, as stated in the Annual ECSA report of 2014/2015. It can clearly be seen that the number of males registered in this category is 1 125, against only 7 females. Therefore, females represent only 0.6 percent of the entire specified registration by gender and category (ECSA, 2015).

Specified Registrations Statistics by Gender & Category		
Category	**Male**	**Female**
Specified	1 125	7

Table 2.5: ECSA – Specified Registrations Statistics by Gender & Category (Adapted from ECSA, 2015)

The ECSA (2015) statistics clearly indicate that women are a minority in engineering. In order to achieve the full potential of a well-balanced staff portfolio, something must be done to attract more women towards a career in engineering. In addition, Ihsen and Buschmeyer (2007) elaborate further that universities should introduce qualifications that address especially female students' needs, in order to make technical career fields more attractive for them (Ihsen & Buschmeyer, 2007).

The importance of women in engineering was discussed above. The following section will review and focus on women studying towards a field in engineering.

2.6. Women Studying towards a Field in Engineering

Engineering is seen as a masculine, objective and impersonal field of study (Holth, 2014; Schreuders et al., 2009; Stonyer, 2002). This is the opposite of what is expected from females to choose a career in. As soon as females enter the university environment, they are already at a disadvantage due to gender inequality (Stonyer, 2002). There could be many reasons for females to distance themselves from male-dominant careers, for example social influences, past experiences or even a female's own perception about certain fields (Bodner et al., 2006). However, during school years, female students were also interested in mathematics and sciences, the same as male students. Female students also excelled in logical thinking compared to the male counterparts (Holth, 2014).

Schreuders et al. (2009) elaborate further that female students are more likely to complete an engineering qualification compared to male students. When choosing an engineering qualification, female students are less likely to change their qualification. In addition, female students entering into any engineering field are more likely to do well and to graduate (Schreuders et al., 2009). However, a European study indicated that female students face difficulties in their interpersonal relationships and have to make extra efforts in order to adapt their study methods. Female students who were assigned a graduate student as a mentor benefited from the relationship, which contributed to their academic and social initiation (Hosaka, 2010).

Jagacinski (2013) also adds that there is still a major need that female students need to be encouraged to choose a career in engineering. They should also be encouraged to complete at least a bachelor's degree level and must not stop at a diploma level. Many factors influence women in choosing a field in engineering. This could either range from, schoolteachers, parents, cultural norms, social pressures (Jagacinski, 2013) or even interest in mathematics and science (Holth, 2014). In addition, Holth (2014) elaborates on women taking on a rational thinking approach in order for choosing a career in engineering, which involves career and job opportunities. Therefore, encouragement is important for female students as they are more likely to drop out during their studies than for male students (Jagacinski, 2013). Therefore, a few barriers may include inconsistent support and adequate encouragement such as lack of knowledge and support from parents, low teacher inspiration and support, lack of extracurricular opportunities, lack of knowledge regarding successful

careers in engineering, anxiety during tests, past performance and lack of interest in certain subjects (Cadaret et al., 2016). Other factors for not completing an engineering course for both male and female students may include that it is too theoretical, not interesting, tutorials were not considered useful, unsuccessful teaching styles or lack of communication (Baillie & Fitzgerald, 2000). In addition, it is important for female students to be in the presence of female academic staff when studying engineering at a higher education institution. Female academic staff serve as role models and mentors for female undergraduate and postgraduate students. This will lead to a critical role that the leaders of the engineering departments and university management play, in order to support the importance of attracting and retaining female students (Mills, 2011). Therefore, students' motivation has an impact on their total study time. However, the workload will have an impact on students' motivation (Cadaret et al., 2016; Kolari et al., 2006).

Seggie's (2014) survey indicates that there is a major shortage of graduates within South Africa, in the field of engineering. Between 1999 – 2011, only 14 percent graduated from the 511 564 who enrolled at a university in South Africa. This means that only 70 475 engineering students graduated, compared to the 1.9m engineering graduates in China, 763 635 in India and 10 765 in the United Kingdom in the same period (Seggie, 2014). Furthermore, the female students who graduate per year in South Africa is approximately only 1 200 students. It is therefore apparent that there is a major problem, which needs to be addressed (Ka-Mnguni, 2009).

Female students can make a significant contribution towards the field of engineering. If universities can increase their number of female engineering graduates, then this will result in a larger number of females entering the pool of engineers. Thus, the quality and the productivity will increase towards improving the standard of living as well as then needs of the society (Burke & Mattis, 2007). Males and females receive the same quality training, which includes the knowledge, skills and experience. Therefore, females are consequently equally equipped as their male counterparts (Perez, 2011).

However, the biggest challenge for these female graduates arises when they enter the full-time workforce. They are confronted with the realities in order to improve society (Baytiyeh & Naja, 2012). Thus, it is very important for universities to equip the female students with the necessary knowledge and skills that are required for high productivity and performance. These graduates must also be equipped to be able to manage potential disappointments in their career, which could also be expectations that are not met (Baytiyeh & Naja, 2012).

The requirements towards any engineering qualification within the South African universities are Mathematics and Physical Science up to grade 12. This is also a major challenge, not only for females, but for males as well. According to Bates (2015), the 2014 pass rate for South Africa for Mathematics is 53.5 percent and for Physical Sciences is 61.5 percent. There is a slight drop in these percentages compared to 2013. It is evident that this will be a limitation in this study. In addition, the number of students able to gain direct entry to engineering, after high school, is relatively small and even decreasing (Mills, 2011). Hartman and Hartman (2007) elaborate further by stating that one of the biggest issues that females face include the differentiating socialisation factors of mathematics and physical science competencies when reaching the end of their matric year. Other issues include the stereotypical threats and social pressures. Therefore, much work needs to be done at high school level regarding these factors. Thus, universities have a responsibility to support this by ongoing outreach programmes (Mills, 2011) and provide opportunities that foster creativity in engineering students (Baillie & Fitzgerald, 2000).

At high school level, both females and males should be informed properly regarding the preconceived notions regarding engineering. Particularly for young girls, feelings of self-efficacy towards engineering can be experienced that can ultimately translate to lower self-confidence at a higher education institution. Therefore, engineering gender stereotypes should be addressed during high school level (Johnson et al., 2013).

Kho (2016) elaborates on some reasons why female students may choose engineering as a career. These may include reasons such as that females are good at mathematics and science at high school level; they enjoy practical activities; they were encouraged by high school teachers; successful female role models; better social status; better job opportunities; able to apply problem solving activities to the real world; they do not mind the male-dominant environment; or simply because they enjoy engineering (Kho, 2016). Other reasons for females not to choose a career in engineering may include that they did not do mathematics and science on high school level; perceived engineering to be a difficult field of study; perceived engineering to be too male-dominant; or that they think it would be difficult to balance work and family life (Kho, 2016).

According to Bhamidimarri and Liu (2016), students studying towards a field in engineering should be taught to make a difference when in the workplace. Problem based learning projects should be included in the curriculum, which could equip students to handle relevant business problems. Undergraduates should have a sound foundation of the following

competencies in their thinking processes, namely effective working with other individuals, excellent problem solving skills, business understanding and planning, financial modelling, opportunity and risk analysis, sustainable development, different development processes, communication skills to achieve outcomes (Bhamidimarri & Liu, 2016), interpersonal skills, teamwork and emotional intelligence (Rasoal et al., 2012). According to Baillie and Fitzgerald (2000), the industry requires employees to be adaptive and transformative, ability to be creative and innovative and employees who are capable of higher level skills. This involves facilitating innovative teamwork. Furthermore, students should be equipped to face a future that is constantly changing. Therefore, students need adequate training that makes them suitable for employability (Baillie & Fitzgerald, 2000; Magnell et al., 2016). This will result in not losing the best graduates to other professions (Baillie & Fitzgerald, 2000).

There are clearly challenges that female students encounter while studying towards a field in engineering.

2.7. Summary

This chapter addressed RQ_1 which states *"Why do male and female students choose a career in Engineering?"* and RQ_2, which states "*What challenges do female students encounter while studying engineering?*". The chapter completed the $RO_{1,}$ which was to identify why males and females choose a career in Engineering and the RO_2, which was to identify the challenges that female students encounter while studying Engineering.

Chapter 2 discussed the different types of engineering and the importance of engineering internationally. Engineering is important to improve the society and to find solutions to improve a country's economy. This includes the ability to implement ideas in a cost effective and practical manner. Some of these solutions may include sustainability, needs of society, necessary risks and protection of the environment. This led to an investigation on engineering within South Africa and the shortage South Africa encounters in producing enough qualified engineers in order to assist the country's economy.

Although men and women are becoming equal partners, the gap between genders remain large. Therefore, this led to an investigation of women in the workplace. Women are under-represented and therefore struggle to achieve management positions. It was also discussed why women tend to leave organisations, due to the different challenges they encounter.

Although engineering is a male dominant field, females are also needed in this profession. Gender inequalities will always exist in this field of study. Some countries provide high numbers of females in engineering, whereas South Africa struggles to provide a high number of graduates. Therefore, the discussion led to women studying towards a field in engineering. Women need to develop certain skills in order to assist with the challenges in this field. Higher Education Institutions in South Africa need to improve the nature of engineering education and need to deliver capable engineering graduates, as well as to meet the critical sustainable developmental goals and needs of the society.

Chapter 3 will provide an inclusive explanation of the research methodology followed in this treatise. Therefore, the research objective of this chapter is focused on RO_3, which would be to identify the research methodology applied in this research study. This will be achieved by asking RQ_3, which questions *"What research methodology can be used for this study?*".

3. RESEARCH DESIGN AND METHODOLOGY

3.1. Introduction

Chapter 2 presented a literature review on the importance of engineering internationally and engineering in South Africa, women in the workplace, women in engineering and women studying towards a field in engineering. The chapter answered RQ_1 namely, "*Why do male and female students choose a career in Engineering?"* and RQ_2, which states *"What challenges do female students encounter while studying engineering?"*. This chapter achieved the research objective (RO_1), by conducting a literature review in order to identify why males and females choose a career in Engineering and to identify the challenges female students encounter while studying Engineering and the RO_2, which was to identify the challenges that female students encounter while studying Engineering.

Chapter 3 provides an explanation of the research design and methodology followed in this treatise. This chapter will address RQ_3 which states, "*What research methodology can be used for this study?*". This research question will be answered through the research objective (RO_3), namely to identify the research methodology applied in this research study. Therefore, current research methodology practices will be reviewed and the suitable research methodologies will be identified and presented. Figure 3.1 illustrates an overview of the research question and research objective of this chapter.

Chapter 3 provides a discussion on research and explains the types of research and research paradigms. Thereafter, the research design used for this study is explained. This chapter also provides each step of the research onion (Saunders, et al., 2012), namely research philosophy, research approaches, research strategies, time horizons and techniques and procedures. Thereafter, the chapter continues to focus on the survey design, the survey respondents and the data collection and analysis methods. A brief explanation is provided on the limitations of the study. The concepts of validity and reliability are discussed. The chapter concludes with a summary of research methodology followed for this treatise. Figure 3.2 illustrates a Structural overview of Chapter 3.

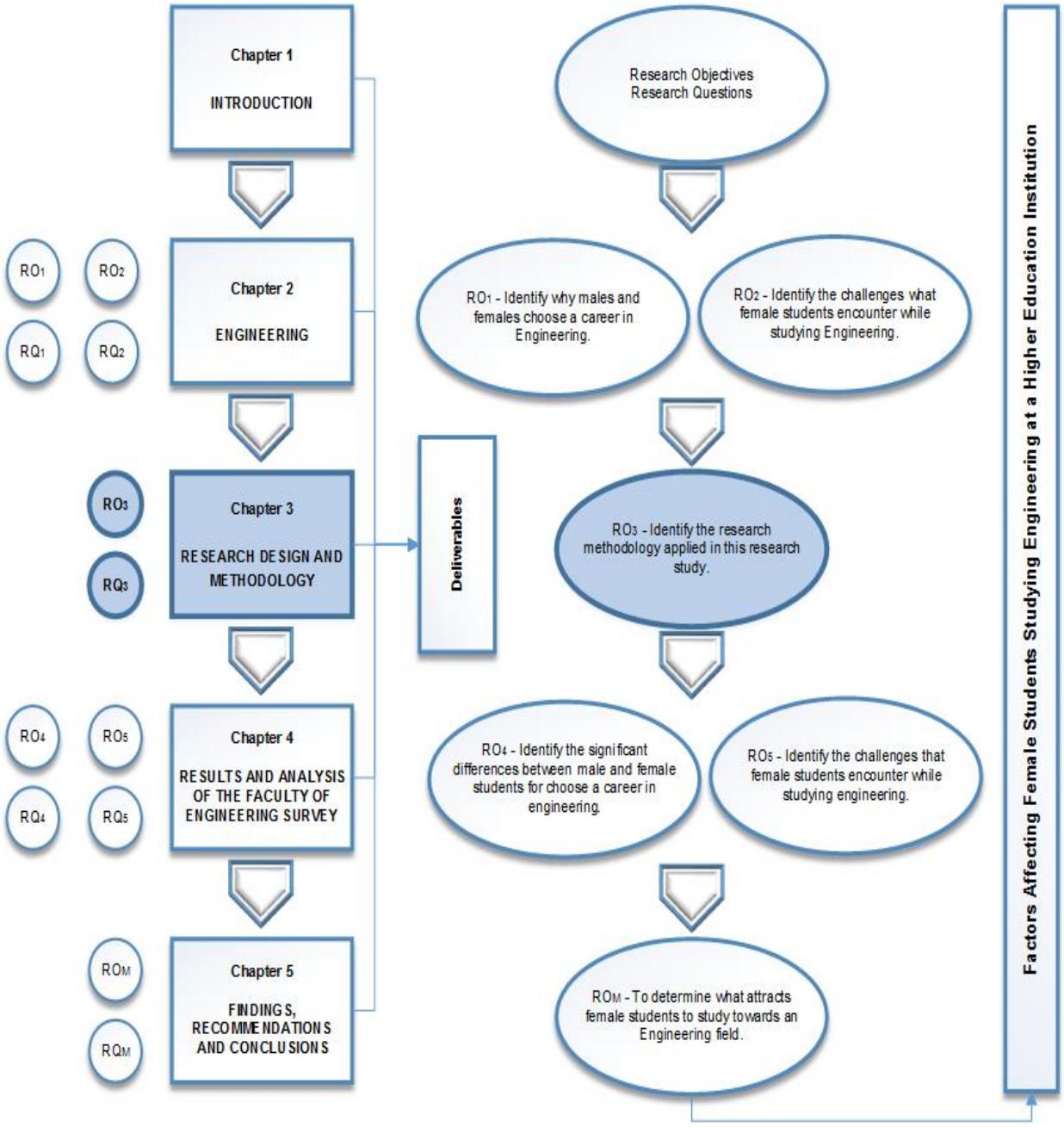

Figure 3.1: Overview of Chapter 3's Research Objective.

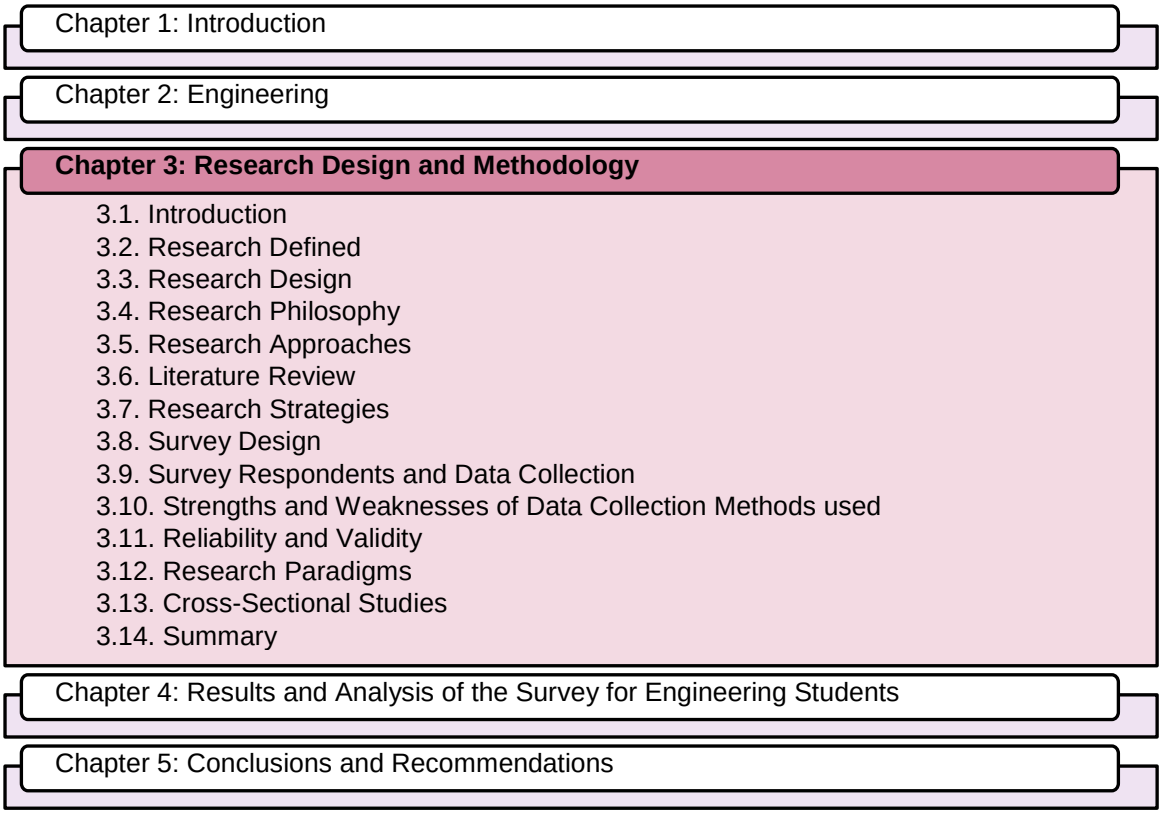

Figure 3.2: Structural overview of Chapter 3.

3.2. Research Defined

Collis and Hussey (2014) define business research as a process of inquiry and investigation; systematic and methodical approaches which increase knowledge. In addition, it is a scientific and systematic search for appropriate and relevant information on a specific topic (Kothari, 2004). It is important for researchers to use applicable and relevant methods for collecting and analysing research data. They need to apply it carefully (Collis & Hussey, 2014). Therefore, research is a search in order to increase the existing body of knowledge, through the process of collecting, analysing and interpreting information, to identify and present a solution to an identified problem (Kumar, 2011; Leedy & Omrod, 2010).

3.3. Research Design

The research design is the overall process of the discussion and identification of the structure, which will be used. This also includes the sampling techniques as well as the data collection methods used in this study (Bell & Bryman, 2007; Krippendorff, 2012). It is critical for researchers to identify a chosen research methodology, as this will result in answering the research design questions in the treatise, by using the data obtained (Collis & Hussey, 2014). In addition, Creswell (2014) commented that the researcher must first identify the

evidence, which will answer the research question, test the theory, evaluate and correctly describe the phenomenon, before the data can be collected or analysed (Cresswell, 2014).

The evidence obtained must be a worthy contribution to the body of knowledge from the field of study. The research onion can be used as a guideline to identify and develop a rational research design. The research design should enable the researcher to identify credible, reliable and relevant data to be collected and action accordingly. Therefore, the research onion provides boundaries, which the researcher can use for relevant evidence collection techniques and analysis procedures (Saunders & Tosey, 2013).

Saunders, et al. (2012) refer to a "research onion", which consists of progressive layers that the researcher must progress through during his or her research. The layers of the research onion are depicted in Figure 3.3 below. The researcher progresses from the outer layer and moves inwards. The research process will begin at the outer most layer, namely the research philosophy. Thereafter, the research moves inwards to the second layer, namely the research approach; the third layer, namely the research strategy; the fourth layer, namely the research choices; the fifth layer, namely the time horizons; and the sixth layer, namely the techniques and procedures (Saunders, et al., 2012). Each of these layers are discussed in more detail from section 3.4 to section 3.11. Sub-sections 3.7.1.4 – 3.7.1.6 and 3.7.2.3 and 3.7.2.5 focus on the data collection and data analysis of the research study.

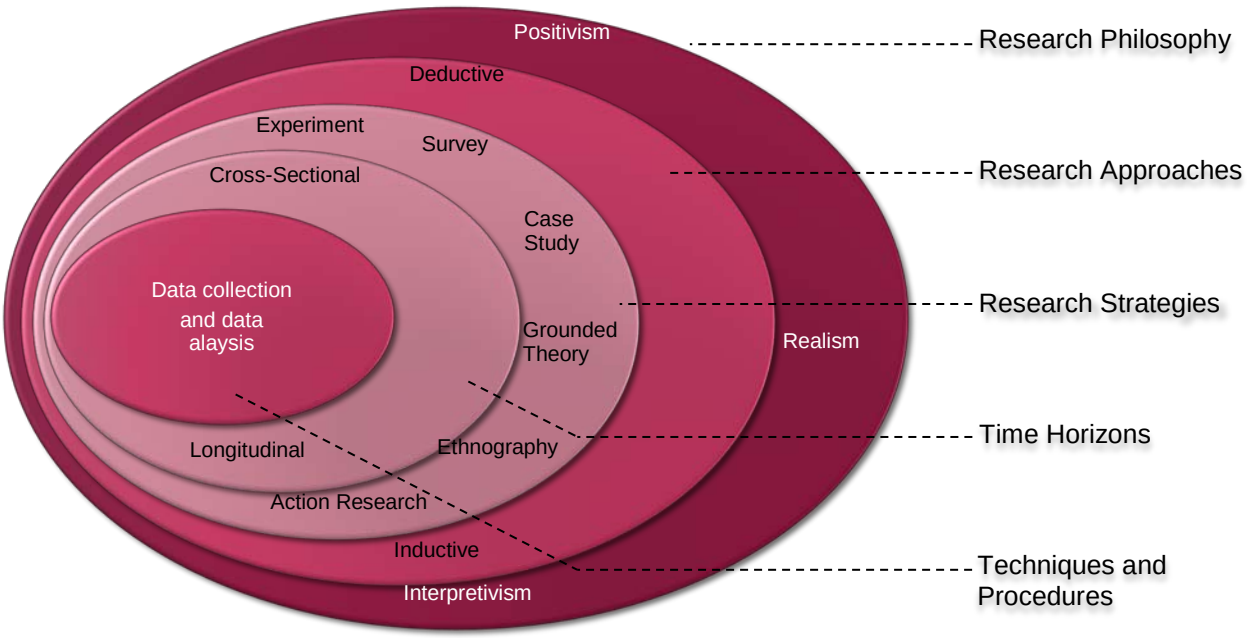

Figure 3.3: The Research Onion (Adapted from Saunders & Tosey, 2013, p. 59).

The following section identifies the three research philosophies and highlights the research philosophy used in this study.

3.4. Research Philosophy

The research philosophy is the first layer of the research onion that is focused on. The research philosophy is built around the assumptions of the researcher as it is the researcher's personal views of the world that constitute acceptable knowledge. A foundation is formed for the research strategy and research methodology around these assumptions. If the researcher is concerned about observational phenomena, then the research study will differ from the researcher who is concerned with the understanding of subjective meanings of feelings and attitudes of certain people. Their choice of research strategy and research methodology will differ considerably. The research philosophy is divided into three major ways of thinking, namely positivism, interpretivism and realism (Saunders, et al., 2012).

The following sub-section elaborates on the three ways of thinking.

3.4.1. Positivism

Positivism is a philosophical system that recognises only that which can be verified scientifically or capable of logical or mathematical evidence. The researcher uses the systematic methods that involve observation and experiment. Inductive logic is applied to discover explanatory theories, which are used for prediction (Collis & Hussey, 2014). In addition, it emphasises empirical data and scientific methods. The researcher can collect knowledge about the real world by observing it. This way of thinking allows the researcher to investigate social reality to have no effect on the environment being examined (Collis & Hussey, 2014; Creswell, 2014). The focus is mainly on existing theory, which is used to develop hypotheses. The hypotheses are tested and result in them being accepted or not accepted (Saunders, et al., 2012). For the purpose of this research study, the positivist way of thinking will be adopted.

3.4.2. Interpretivism

Interpretivism is an approach to social science, which is opposite to positivism. It integrates human elements into the research study. The researcher interacts with that being researched, with a view to gain interpretive understanding. Therefore, it is impossible to separate what exists in the social world from that in the researcher's mind (Collis & Hussey, 2014). Interpretivism focuses on meaning, through in-depth investigations with smaller samples, which may include multiple methods, in order to reflect different aspects of the

issue, in order to answer the research questions. Interpretivism can be used in changing research environments, such as human resources management, organisational behaviour and marketing (Saunders, et al., 2012).

3.4.3. Realism

Realism, similar to positivism, is associated with a scientific approach. The way of thinking of the researcher and belief that social reality are independent of each other and therefore will not create biased results (Saunders, et al., 2012). The researcher conducts the study in more natural settings and more situational or contextual data are collected. This may result in the researcher using collection techniques and analysis procedures from both quantitative and qualitative approaches.

The following section discusses the research approaches and the research approach used in this research study.

3.5. Research Approaches

The research onion's second layer focuses on the research approaches. These research approaches are divided into two general approaches to research, namely deductive and inductive reasoning. These research approaches result in achieving new knowledge (Hyde, 2000). Figure 3.4 below, depicts the two research approaches.

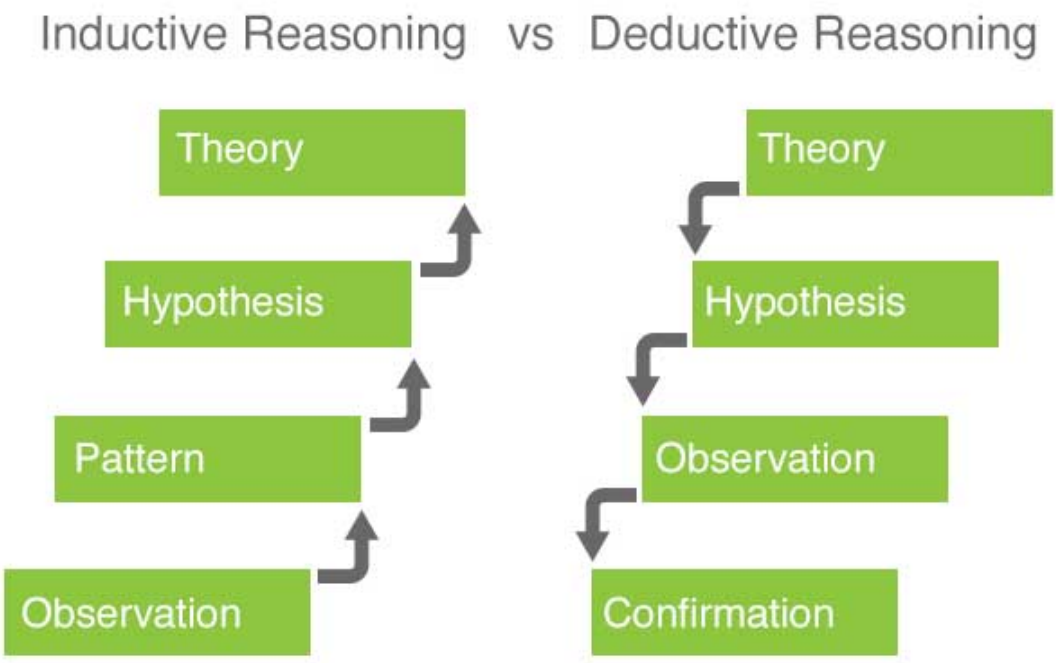

Figure 3.4: Inductive vs. Deductive Reasoning (Adapted from Trochim, 2006).

Deductive reasoning is also known as the 'top-down' approach, starting with the theory or generalisation and progresses towards where the theory applies to specific cases (Hyde, 2000). This reasoning involves the collection of specific information or data on the variables. It begins at the theory and narrows it down, by testing a hypothesis. The researcher can even collect observations to address the hypothesis (Collis & Hussey, 2014; Trochim, 2006).

Inductive reasoning is also known as the 'bottom-up approach, starting with observations of specific cases and progresses towards the established generalisations regarding the phenomenon under investigation. Therefore, it is also recognised as a theory building process (Hyde, 2000). In addition, the researcher can create a tentative hypothesis that can be explored and finally end up developing some general conclusions or theories (Mason, 2002; Trochim, 2006).

For the purpose of this research study, deductive reasoning is adopted, due to the study processing from broader generalisations and theories to instances that are more particular. The following section elaborates on the literature review.

3.6. Literature Review

The following sub-sections define the literature review, thereafter the purpose of the literature review is elaborated on as well as elaboration on what literature were used for this study.

3.6.1. Literature Review Defined

According to Hofstee (2006), a good literature review is "comprehensive, critical and contextualised" (Hofstee, 2006, p.91). In addition, it guides the researcher to evaluate and explore the existing body of knowledge on a specific topic or research problem. Therefore, it demonstrates awareness of the current state of the knowledge on the specific topic. It identifies limitations and how the research fits into the wider context (Collis & Hussey, 2014; Saunders, et al., 2009). Major questions and problems in the field of study should be covered in the literature study. This literature should include any previous published work in the field of study, such as books, journal articles, presentations, conference papers, websites, dissertations, theses and treatises (Collis & Hussey, 2014; Creswell, 2014).

3.6.2. Purpose of Literature Review

The purpose of a literature study is to analyse methodologies used in previous studies, in order to gain insight in the subject matter. Therefore, the strengths, weaknesses and

significance conducted in previous studies, provide the researcher with insight and knowledge of the field of study. This strengthens the existing body of knowledge (Hofstee, 2006). The literature review also identifies new approaches, ideas and perspectives that have not occurred to the researcher (Leedy & Omrod, 2010). A sophisticated and thorough literature review lays a foundation for a respected research study that is able to increase collective understanding as well as to contribute to the existing body of knowledge (Leedy & Omrod, 2010).

3.6.3. Literature Review Process for this Study

Leedy and Omrod (2010) explain that keywords or phrases are very important to use when searching for literature, as it is a summary of the topic being researched. Therefore, keywords can find potential relevant resources. The ability to review research of others and to evaluate the quality of their methods, results, and conclusions is an import skill for any researcher. The researcher improves his or her own research efforts, by developing an ability to evaluate other researcher's publications (Leedy & Omrod, 2010).

For the purpose of this research study, the Nelson Mandela University Library research system was used to obtain relevant literature. For current online publications, Google Books and Google Scholar were also used extensively. Although hardcopy textbooks were used for this field of study, the majority of research was performed through searching of academic and other databases online. This was useful to find online journal articles or publications. This method has the following advantages:

- *Easy access* – Online material can easily be accessed;
- *Currency and availability* – Publications are readily and available, which is up-to-date, whereas hardcopies take longer before available in the library. Therefore, soft copies are always available;
- *Flexibility* – It allows the researcher to use any keywords which they feel suit the relevant search;
- *Cross-disciplinary search* – Multiple areas can be search with only one search; and
- *Searching speed* – The researcher is able to search through millions of publications within a few seconds and use those that are relevant to the field of study (Collis & Hussey, 2014).

The researcher commenced by reviewing the most recent publications and then moved to earlier literature or publications. Relevant and important information was highlighted in each article. Within the relevant publications, the references and authors were identified which

result in previous relevant publications, which could be used. The processed literature was then discussed with the researcher's supervisor for any input and approval.

The following section discusses the research strategies.

3.7. Research Strategies

The research onion's third layer focuses on the research strategy (ies). A research strategy is a complete process or general plan for collecting and/or analysing data (Collis & Hussey, 2014; Leedy & Omrod, 2010). Therefore, it is a technique, which allows the researcher to identify and create research questions, in order to focus on the research objectives. Researchers can use more than one research strategy within their research design, in order to assist in answering their research questions (Saunders & Tosey, 2013). The strengths, weaknesses and limitations of the research methodology are emphasised, while the researcher designs and executes his/her research strategy (Leedy & Omrod, 2010).

Research can be conducted, by using the following research strategies (Saunders, et al., 2012). These research strategies are:

- Experiment;
- Survey;
- Case Study;
- Grounded Theory;
- Ethnography; and
- Action Research (Creswell, 2014; Saunders, et al., 2012).

For the purpose of this study, to achieve the required research objectives, a survey was used.

The following section discusses the survey design, which includes a description of the survey, the questionnaire scale, validity and reliability that are used for the purpose of this study.

3.8. Survey Design

The following sub-sections define survey research, the description thereof as well as the scale, validity and reliability of the questionnaire used.

3.8.1. Survey Research Defined

One of the most common methods of collecting primary or secondary data from samples through direct questioning of respondents are surveys. Survey research can be highly structured questionnaires from internet self-completion questionnaires, to unstructured questionnaires such as face-to-face or telephonic interviews (Collis & Hussey, 2014; Hofstee, 2006). Questionnaires are a helpful tool in order to structure and record the collection of data, in order to gain insight in the respondent's opinions, ideas, desires, attitudes and values (Kumar, 2011; Wegner, 2012). The results are then analysed and generalised to the population of the study (Collis & Hussey, 2014).

For this research study, an electronic questionnaire is used as a form of structured interview. This allows all respondents to answer the same questions in the same format (Krippendorff, 2012).

3.8.2. Survey Description

A covering letter was send to the respondents of the survey. It introduces the topic, background to the field of study and purpose of the study. The confidentiality statement and the benefits of participating in the survey are also included in the cover letter (Appendix C). The respondents are given the expected time to complete the survey. It is emphasised that all personal information will be kept confidential and that automatic consent is provided through participation.

The survey is divided into seven sections. These are:

- Section 1: Biographical information captures the respondent's gender, age, qualification he/she is enrolled for, and year of study;
- Section 2: Interest in engineering and reasons for choosing engineering;
- Section 3: Experience during engineering studies captures the general experience that both male and female students encounter during their studies;
- Section 4: Most influential people during studies captures the respondents general feeling regarding who influenced their interest the most or the least;
- Section 5: Campus/University support captures the respondent's experience while studying a field in engineering and what support are there from the university side.

Most of the questions in the questionnaire are either multiple choice or a five point Likert Scale type questions. The respondents are allowed to add their feelings and perception in a few additional open-ended questions.

3.8.3. Questionnaire Scale, Validity and Reliability

In order to assist with the survey, information identified from the literature was used. Thereafter, previous surveys from academic journal articles and other published research were made available and analysed. Thus, the structure of the questions used for the questionnaire was modified based on certain topics highlighted. The questions in the survey were adapted to suit the Nelson Mandela University environment. The current Nelson Mandela University requirements and environment are stipulated in the MANCO report and were used as a guideline. Table 3.1 below presents a list of literature sources, which were used as discussed, in order to assist this questionnaire with reliability and validity. It is ensured that the questions or statements used in this survey are related to the primary research question and secondary research question.

Independent Variable	Literature Source
Interest in Engineering	(CASEE, 2005; Kho, 2016; Mills, 2011; Watkins, 2011)
Influencers during Studies	(Baillie & Fitzgerald, 2000; Kho, 2016; Watkins, 2011)
Readiness (Mathematics and Physical Science exposure)	(Francis, 2009)
Experience during Studies	(Francis, 2009; Mills, 2011; Watkins, 2011)
Campus/University Support	(Francis, 2009)
Faculty Feedback	(CASEE, 2005; Francis, 2009)

Table 3.1: Survey items literature sources.

As mentioned previously, the Likert Scale rating was used for the majority of questions in this questionnaire. Instructions were given to respondents to select the most suitable answer. These type of questions are the easiest to construct as this measures the respondents' attitudes. Each statement or item on the scale is equal in value (Kumar, 2011). A five point Likert Scale rating, listed the findings in the survey that included the following:

- Greatly decreased (1), Slightly decreased (2), Stayed the same (3), Slightly increased (4), and Greatly increased (5);

- Never (1), Almost never (2), Sometimes (3), Almost always (4), and Always (5);
- Strongly Disagree (1), Disagree (2), Neutral (3), Agree (4), and Strongly Agree (5);
- Great deal of discouragement (1), A little discouragement (2), Neither encouraged or discouraged (3), A little encouragement (4), and Great deal of encouragement (5);
- Once a week (1), 1 – 3 times a month (2), 1 – 3 times a semester (3), Once a year (4), and Never (5).

In addition to the above scale, dichotomous questions were used, namely where the respondent were to indicate 'yes' or 'no'. Multiple choice questions were also used. Each respective question or statement allowed respondents to indicate their point of view. For the purpose of this study, each identified topic was addressed by these specific questions or statements. After the questionnaire had been compiled, it was discussed with one of the senior academics at the Nelson Mandela University Business School, namely Prof Margaret Cullen. Thereafter the questionnaire was submitted to the REC-H Committee for approval and/ or recommendations. See Appendix B for the Ethical Clearance form with resolution number, namely H16-BES-BUS-022.

The following section will focus on the survey respondents and data collection.

3.9. Survey Respondents and Data Collection

The fifth layer of the research onion focuses on identifying the different data collection and data analysis techniques that could be used in a study (Saunders & Tosey, 2013). The following sub-sections elaborate on the population, questionnaire distribution and questionnaire data analysis that was used for the purpose of this study.

3.9.1. Population and Sample

For the purpose of this study, the population is all Nelson Mandela University students registered for an Engineering qualification. Sampling is a subset of data value derived from the population, also known as sample. A sample is used when it is not possible to record every data value from the entire population, mainly due to time, cost and possible destruction of the object being measured or observed (Cooper & Schindler, 2011; Wegner, 2012). For the purpose of this study, a non-probability sampling method was incorporated by means of convenience sampling and random sampling, because the researcher has convenient accessibility to the respondents (Kumar, 2011). In total, there are 1 716 potential respondents.

The population group consists of 1 716 registered Nelson Mandela University undergraduate students in the School of Engineering. From this total, 1 377 are registered male students and 339 are registered female students. It is therefore clear that all Nelson Mandela University undergraduate engineering students qualify for this research study and would consequently be invited to participate.

Both male and female students were used for this study, so that a comparison between these genders could be conducted. The main focus remains on female students and what problems they encounter while studying engineering.

The survey required all currently enrolled undergraduate Engineering students to complete the survey. Therefore, in order for respondents to qualify to participate in the survey, the preconditions were that they must be a student at Nelson Mandela University and currently enrolled for any undergraduate engineering qualification. Through means of a compiled distribution list, an email was sent out, which contained a link to the survey. This email was sent to all undergraduate Engineering students.

3.9.2. Questionnaire Distribution

Primary data were used in this study for the data collected, as it did not exist prior to this research being conducted. Full ethics clearance was required for this study. See Appendix B for the consent form with resolution number, namely H16-BES-BUS-022. The sample was collected by distributed a survey (Appendix C) to the respondents. The survey was created by using the Nelson Mandela University survey tool. It is known as a professional toolkit in order to create surveys. The respondents were students at Nelson Mandela University, who were registered in 2016 for an engineering related qualification. This includes all undergraduate students registered in the School of Engineering, namely Civil Engineering, Electrical Engineering, Industrial Engineering, Mechanical Engineering and Mechatronics. All respondents were required to provide feedback and their opinions on the same questions.

A distribution list was compiled, which contains all possible respondents to participate in this study. An email with a Universal Resource Link (URL) to the survey was sent to participants on the distribution list. See Appendix C for the distribution email. In addition, to increase the response rate, participants were also presented with a hard copy of the survey. After completion of survey, it was automatically returned to the researcher. Confidentiality and anonymity of the participants was preserved and no names were mentioned in this study. In

total 1 716 emails were sent out to potential respondents. From this total, 303 participants responded.

See Appendix D for the questionnaire. The purpose of the questionnaire is to collect relevant data on the experience of both male and female students. These respondents will be asked to identify the different reasons why they (female and male students) chose a career in engineering and this will include the challenges they face while studying engineering. Therefore, the survey will assist the researcher to gain insight into the different factors that affect female students while studying in a field of engineering at Nelson Mandela University.

3.9.3. Questionnaire Data Analysis

Due to using the online survey service, the responses or data were automatically tabulated, by using the export function of the tool, into Microsoft Excel format, which would ease the analysis process. The hard copies, which were received from the respondents, were entered onto the datasheet manually. The data were analysed and any corrupt or incomplete records were removed from the datasheet. One of the statisticians at Nelson Mandela University, assisted with the analysis of the data. Descriptive and Inferential Statistical methods were used to analyse the collected data and to draw conclusions. Descriptive statistics includes the measurement of central tendency, such as mean, median and mode and inferential statistics include specific measurement of association such as the Chi-Square analysis. In addition, the reliability of the instruments was calculated by using Cronbach alphas.

The following section will briefly discuss the strengths and weaknesses of the data collection method, which was used for this study.

3.10. Strengths and Weaknesses of the Data Collection Methods Used

The distribution of an electronic survey as a data collection method, could have the following advantages: it is a cost-effictive method; it saves time, as it is returned immediately, comparing to other data collection methods; it is easier to administer; capible of collecting data from a large number of respondents; a broad range of data can be collected; and respondents can answer more honestly, because it is anonymous (Saunders, et al., 2009; Wyse, 2012; Zikmund, et al., 2010).

The distribution of an electronic survey as a data collection method, could have the following weaknesses: an important participant could be missed in the study; respondents may be dishonest about certain answers; respondents may feel uncomfortable providing answers, which may present them in an unfavourable situation; close-ended questions in surveys, may contain a lower validity rate than other type of questions; data errors may exist due to non-responses; and researcher has limited or no control over the way respondents answer the questions (Saunders, et al., 2009; Wyse, 2012; Zikmund, et al., 2010).

The following section elaborates on the reliability and validity in this research study.

3.11. Reliability and Validity

The credibility of research findings has two characteristics, namely reliability and validity (Collis & Hussey, 2014). In addition, Leedy and Omrod (2010) emphasise the probability of learning something from the study, the probability of obtaining statistical significance from the study and the extent to draw meaningful conclusions from the data analysis (Leedy & Omrod, 2010). Thus, these are all influenced by the reliability and validity of the measurement tool (Leedy & Omrod, 2010; Quinn et al., 2009). In addition, it reduces the possibility of not answering the research question (Saunders, et al., 2009). Figure 3.5 below, depicts the differences between reliability and validity.

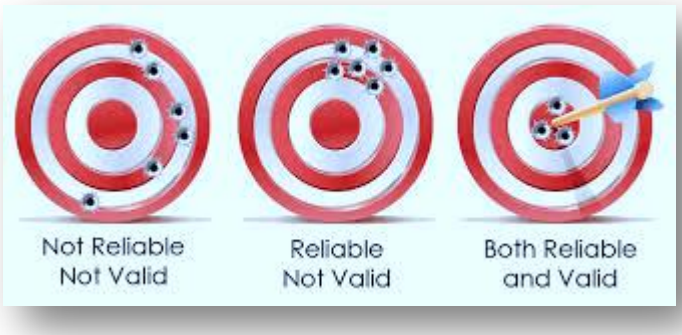

Figure 3.5: Reliability and Validity of data (Callans, 2012).

The following sub-sections will discuss these two characteristics.

3.11.1. Reliability

Reliability refers to the accuracy and precision of the measurement, which serves as an indicator of consistency and whether repeated studies will indicate the same results (Collis & Hussey, 2014). Thus, a repeat study should produce the same result, in order for a research result to be reliable. Therefore, if the research tool being used is consistent, stable,

predictable accurate, trustworthy, dependable and replicable over time, the research result is then reliable. Reliability will be greater, when the degree of consistency and stability in the instrument is greater (Collis & Hussey, 2014; Kumar; 2011). In addition, if results are inconsistent, no matter when the different studies are done over time, then the study is considered as not reliable (Callans, 2012). Reliability is of little importance for interpretivism studies and of higher importance in positivist studies (Collis & Hussey, 2014).

Measuring instruments for psychological characteristics (insubstantial phenomena) tend to be less reliable than those measuring instruments designed to measure physical (substantial phenomena). This is because a variety of biased factors can easily influence the psychological characteristics. These factors include individual's perception, interpretation of and prejudice (Leedy & Omrod, 2010).

Something can be measured accurately, only when it is measured consistently. However, it does not necessarily mean that if something is measured consistently, that it is accurate. Therefore, reliability is necessary, but an insufficient condition for validity (Leedy & Omrod, 2010).

There are many different kinds of tests at the researcher's disposal that can be used to test the reliability of a research study. These include:

- Stability (Test-retest Correlation)

  The stability test, known as test-retest correlation, indicates stability over a period. This test involves performing a study on the same population more than once. The timeframes should be taking into consideration. The timeframes should be short enough that the concepts itself did not changed. By using correlation coefficients, the results of the two tests are compared. A correlation coefficient measurement close to zero, indicates a low reliability, while a correlation coefficient measurement close to one, indicates a high reliability. One of the disadvantages of the stability test is that respondents might replicate their responses from the previous study again during the repeated study. This will result in a high reliability (Collis & Hussey, 2014; Drost, 2011).

- Equivalent

  The equivalent test involves using two different but same measuring instrument on the same population and within the same environment. The correlation coefficient will not

be affected by memory effects, during the performance of the second test (Collis & Hussey, 2014).

- Split-half reliability

  The split-half test involves splitting the measurement procedure into two separate instruments. Thus, the correlation coefficients of the two instruments are compared and thereafter calculated to indicate reliability (Collis & Hussey, 2014; Drost, 2011).

- Internal Consistency (Homogeneity)

  The internal consistency test, also known as homogeneity, involves by measuring the instrument responses, in order to calculate the internal consistency. Cronbach's alpha coefficient is used to measure this internal consistency. It is important that Cronbach Alpha is not as statistical test, but a coefficient of reliability. The set intervals for Cronbach Alpha are as follows:

  - Cronbach Alpha ≥ 0.90 - high reliability;
  - Cronbach Alpha ≥ 0.80 - moderate reliability;
  - Cronbach Alpha ≥ 0.70 - low reliability; and
  - Cronbach Alpha ≤ 0.70 - unacceptable reliability (Collis & Hussey, 2014; Maree, et al., 2012; Nunnally, 1978).

As from the above indicated intervals, it is clear that a high coefficient value indicates a high reliability, whereas a low coefficient value indicates an unacceptable reliability. For exploratory or basic research, it is regarded as acceptable if the Cronbach Alpha value is higher than 0.50 (Collis & Hussey, 2014; Maree, et al., 2012; Nunnally, 1978).

3.11.2. Validity

The validity of a measuring instrument is concerned with the extent to which the measure actually does capture the concept that the researcher is trying to measure. In addition, whether the data collected, represent a true picture of the concept being studied (Collis & Hussey, 2014; Leedy & Omrod, 2010). Validity also refers to the level or strength of certainty when the researcher wants to make recommendations or suggestions as result of the findings in the study (Yin, 2009).

There are several strategies for assessment of validity. These strategies include:

- Face Validity

  Face validity ensures or logically appears to reflect if the measurement that is used, actually measure what it is intended to measure. Face validity is the easiest form of validity to implement. However, based on subjective logic, it is one of the weakest forms of validity (Collis & Hussey, 2014).

- Content Validity

  Content validity is achieved when the instrument measures the relevant content of the construct that the researcher attempts to study (Collis & Hussey, 2014). In addition, the researcher judges whether the measurement fully represent the field of study. Thus, content validity is a qualitative means of ensuring that the indicators emphasise the meaning of the concept as defined by the researcher (Drost, 2011).

- Criterion-related Validity

  Criterion-related validity is the degree of correspondence between a test measure and one or more external referents (criterion), which is usually measured by their correlation. Measuring procedures could possibly include surveys, structured interviews, etc. (Drost, 2011). The criterion-related validity tests can be divided into two different timeframes, which could be used, namely concurrent validity and predictive validity. Concurrent validity is when the criterion exists at the same time as the measure. Therefore, this ability refers to the test being able to predict an event in the present. Predictive validity is used when the criterion occurs in the future. This will allow the researcher to make accurate predictions that must be completed in relation to the theory (Drost, 2011).

- Construct Validity

  Construct validity identifies the correct operational measures for the concepts being studies and ensures whether the instrument measures hypothetical concepts (Creswell, 2014; Yin, 2009). It also focuses on the problem where the results serve a useful purpose and it serves a positive consequence when they are used in practice (Creswell, 2014). This method is important where intangible objects are being measured and are not directly observable. This includes emotions, such as desire, satisfaction, anxiety and motivation (Kumar, 2011).

In addition to the validity of the measurement procedure, it is not only the measurement tool's validity to consider, as well as validity as a whole, such as the accuracy, meaningfulness and credibility of the research project. Therefore, the study must enable the researcher to draw meaningful conclusions (Leedy & Omrod, 2010). In addition, Kumar (2011) and Yin (2009) emphasise that during the research procedures, such as the study design, sampling strategy, measurement procedures, statistical analysis or during the conclusion, many negative aspects can appear (Kumar, 2011; Yin, 2009). There are two sub-categories to research validity. They are as follows:

- Internal Validity

  Internal validity is to which degree the results are attributable to the independent variable. This includes whether the independent variable has any effect on the dependent variable (Kumar, 2011; Zikmund et al., 2010). In addition, the research study itself could be affected by certain factors. There are a few threats to internal validity, if they are not controlled, namely history, maturation, testing, instrumental or task sensitivity, statistical regression, research reactivity, experimental mortality (attribution) and selection interactions (Creswell, 2014; Zikmund et al., 2010). Therefore, if the observed results or findings were influenced by any factors, the researcher will have problems making valid conclusions about the relationship between the independent and dependent variable (Zikmund et al., 2010).

- External Validity

  External validity of a research study refers to the extent or accuracy to which the results of the study can be generalised to other populations and contexts (McLeroy & Steckler, 2008). In addition, the higher the external validity, researchers will be able to conclude that any results or findings in the study could be noticed in the 'outside world'. If a study lacks external validity, then the researcher will have difficulty repeating the study, with any change in the subject, time or settings (Zikmund et al., 2010). Threats to external validity include pretesting, settings, interaction and multiple interventions (Creswell, 2014; Drost, 2011).

The following section defines research paradigms, explains the three research paradigms and identify the research paradigm used in this study.

3.12. Research Paradigms

A research paradigm is the philosophical framework that guides researchers on how their scientific research should be conducted (Collis & Hussey, 2014). Research philosophy is

the researcher's assumption and personal views of the world that constitute acceptable knowledge. A foundation is formed for the research strategy and research methodology around these assumptions. If the researcher is concerned about observational phenomena, then the research study will differ from the researcher that is concerned regarding the understanding of subjective meanings of feelings and attitudes of certain people. Their choice of research strategy and research methodology will differ considerably. The research paradigm is divided into two major approaches, namely quantitative research and qualitative research (Collis & Hussey, 2014; Creswell, 2008; Saunders, et al., 2012).

The following section discusses the three main research paradigms, namely quantitative research, qualitative research and mixed methods.

3.12.1. Quantitative Research

Quantitative research focuses on conducting research in the natural sciences and these methods are still mainly used in social sciences today (Collis & Hussey, 2014). This approach primarily follows the confirmatory scientific method, because the main focus remains on hypothesis testing and theory testing (Christensen & Johnson, 2012). Therefore, quantitative research is a type of empirical research. It describes phenomena according to numerical data, which are analysed by means of mathematically (numeric) equations, such as statistics (Yilmaz, 2013). Collis and Hussey (2014) elaborate further by stating that quantitative approaches state that valid knowledge stems from objective evidence that can be scientifically proved. In addition, quantitative research relies on deductive reasoning processes to interpret and structure the meaning, which has been derived from the data. Thus, it endorses a view that believed that the social phenomena has an objective reality being external to the studied subjects (Neuman, 2006; Yilmaz, 2013). The researcher should put distance between themselves and what is being researched. Therefore, almost like having an 'outsider view' (Creswell, 2014). However, it focuses on maintaining an independent and objective position towards reality, where the results are based on larger sample sizes (Collis & Hussey, 2014). In addition, the aim in conducting a quantitative research study is to determine the relationship between an independent variable and a dependent variable within a specific population (Babbie, 2010).

3.12.2. Qualitative Research

Qualitative research relies on inductive reasoning processes, in order to interpret and structure the meaning as derived from data. This approach agrees on an interpretation that believes that the social reality is shaped by human perceptions and subjective (Collis &

Hussey, 2014; Morgan & Smircich, 1980). Qualitative research is normally conducted when little is known and if the researcher wants to discover or learn more about the topic or phenomenon. This approach primarily follows an exploratory scientific method (Christensen & Johnson, 2012). Therefore, qualitative data can be classified as the opposite of quantitative data. Thus, the findings are not derived from statistical procedures or other means of quantifications (Eriksson & Kovalainen, 2014; Yilmaz, 2013). The researcher develops a close, empathetic relationship with the studied subjects and therefore, is seen as having an 'insider view'. Qualitative researchers search to study research problems by investigating the interpretations, perceptions, understandings and meanings of groups or individuals assign to a social or human issues (Creswell, 2014; Eriksson & Kovalainen, 2014). The collected data are seen as the primary source of data. The emerging qualitative research approach is then used to collect the data in a natural setting that is sensitive to the data subject being studied (Creswell, 2014; Collis & Hussey, 2014). Therefore, it tries to understand how a social experience is created and gives meaning, which came from the inextricably connected relationship between the researcher and the field of study (Yilmaz, 2013).

3.12.3. Mixed Methods

Mixed methods, also known as mixed methodologies, are the combination of both quantitative and qualitative research techniques. Therefore, the researcher combines the paradigms, methods, techniques, concepts, approaches, or languages into one research study (Christensen & Johnson, 2012; Greene, 2007). Therefore, it allows the researcher to obtain an in-depth understanding, perceptive and complexity in a way that produces an overall design with multiple (convergent and divergent) and complementary strengths and non-overlapping weaknesses (Johnson, 2014).

3.12.4. Research Paradigm for this Study

For the purpose of this study, the mixed method approach is used, with the majority being quantitative research. The researcher aims to gain insight into the experience and knowledge of the individuals in the given research problem. The data collected would be used to assist the researcher to interpret and structure the meanings that derived from the data. This will result into a better understanding and gaining of knowledge of the reality of the research problem. In order to generalise the findings in relation to the population, in a systematic and objective method, numeric data will be collected and analysed. The following section will focus on cross-sectional studies.

3.13. Cross-Sectional Studies

Time horizons are the fourth layer of the research onion. In the following sub-sections, focus is on defining cross-sectional studies, what is the purpose of cross-sectional studies and elaborate on the cross-sectional studies used in this study.

3.13.1. Cross-Sectional Studies Defined

Cross-sectional studies are used, when the researcher gains samples and collects data in various segments of a population at a single point in time. In addition, the survey will ask the respondents to reflect on their experience that occurred in the past (Collis & Hussey, 2014; Zikmund et al., 2010). Cross-sectional studies are most commonly used in research studies. This design is therefore best suited to those studies aimed at finding out the prevalence of a phenomenon, a specific situation, attitude, problem or issue, by taking a cross-section of the population. It is useful to obtain an overall 'picture' at the time of the study (Kumar, 2011). This means that the researcher can obtain a broad sample that includes people of different ages, different religions, different levels of income, different educational backgrounds etc. (Saunders et al., 2009).

3.13.2. Purpose of Cross-Sectional Studies

The purpose of cross-sectional studies is that the researcher can record information about the subjects, without manipulating the study environment. Mostly surveys are used in quantitative research studies and mostly interviews are conducted for qualitative research studies (Saunders et al., 2009).

3.13.3. Cross-Sectional Studies for this Study

As previously mentioned, a distribution list was compiled which contains all possible respondents to participate in this study. The Engineering survey was compiled and distributed to all Nelson Mandela University undergraduate students studying an engineering qualification. The cross-sectional study will allow the researcher, at the same time, to compare many different variables and as necessary to draw conclusions. Thus, factors affecting female students while studying engineering, before and after this study will not be used in this study.

3.14. Summary

Chapter 3 commenced by defining research. Thereafter, by using the research onion, each aspect was discussed, namely the research philosophy, the research approached, research strategies, time horizons; and techniques and procedures. For the purpose of this study, the

chosen methods are positivism, deductive reasoning, surveys and cross-sectional studies. Thus chapter 3 addressed RQ_3 which states "*What research methodology can be used?*". Therefore, this chapter completed the RO_3, which was to identify the research methodology applied in this research study.

Chapter 4 will identify and discuss the statistical analysis that was gathered for the purpose of this study. Therefore, Chapter 4 will address RQ_4 which states, "What are the significant differences between male and female students for choosing a career in engineering?" and RQ_5 which states "What are the challenges that female students encounter while studying engineering?". This will be achieved by focusing on the research objectives of this chapter, namely RO_4 which will be to identify the differences between males and female students for choosing a career in Engineering and by focus on RO_5 which will be to identify challenges that female students encounter while studying engineering.

Chapter 4

4. RESULTS AND ANALYSIS OF THE ENGINEERING SURVEY

4.1. Introduction

In the previous chapter, the research design was discussed by means of referring to the research onion. The research philosophy, research approaches, research strategy (ies), time horizons and techniques and procedures regarding this research study were indicated in a layered approach in the research onion. The chapter concluded by summarising the followed research methodology of this treatise.

Chapter 4 addresses RQ_4 which states, "*What are the significant differences between male and female students for choosing a career in engineering?*" and RQ_5 which states "*What are the challenges that female students encounter while studying engineering?*". The objective of this chapter is to conduct an empirical evaluation regarding the experience male and female students encounter while studying at Nelson Mandela University. Therefore, the significant differences between male and female students for choosing a career in engineering (RO_4) and to identify the challenges that female students encounter while studying engineering (RO_5). Figure 4.1 depicts an overview of the research question and research objective of this chapter.

A comprehensive analysis of the empirical data collected is provided in Chapter 5. Each research question is analysed and these findings are indicated in a logical manner. A summary of the findings will be concluded in this chapter. See Figure 4.2 for a Structural overview of Chapter 4.

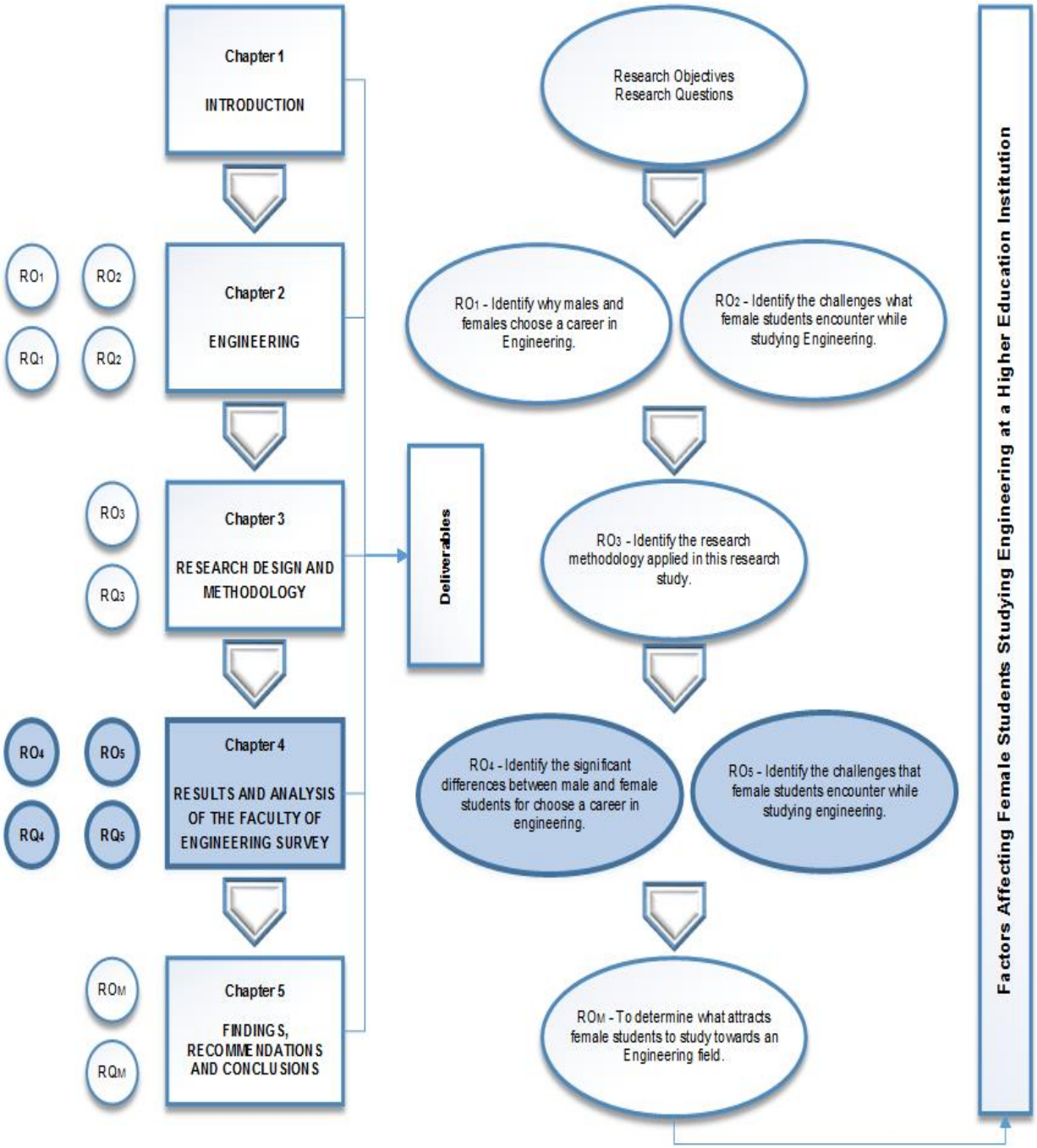

Figure 4.1: Overview of Chapter 4's Research Objectives.

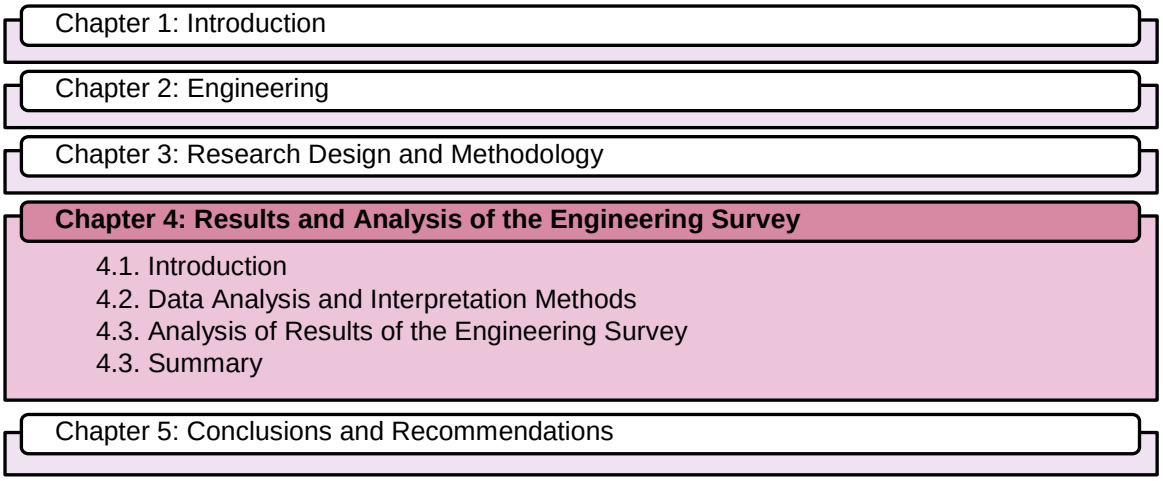

Figure 4.2: Structural overview of Chapter 4.

4.2. Data Analysis and Interpretation Methods

A few data analysis methods were used to analyse this study's primary data. These methods will briefly be mentioned below.

4.2.1. Frequency distribution

A frequency distribution is a summary of frequencies for all the collected data values for a particular variable (Collis & Hussey, 2014). This can be found in Section 1 of the questionnaire, where categorical data, such as *Gender, Age, Ethnic Group, Home Language, Province, Qualification* and *Year of Studies* are displayed by using pie charts and bar charts. This will simplify the analysis and interpretation of results.

4.2.2. Pearson's Correlation

Pearson's correlation coefficient is a parametric test and is used to measure the strength of the linear association between two variables (Collis & Hussey, 2014; Wegner, 2012). Therefore, the strength of the correlation is indicated by the correlation coefficient. The guidelines for interpretation are as follows:

- +1.00 - Perfect positive linear association;
- +0.90 to +0.99 - Very high positive correlation;
- +0.70 to +0.89 - High positive correlation;
- +0.40 to +0.69 - Medium positive correlation;
- +0.01 to +0.39 - Low positive correlation;
- 0.00 - No linear association;
- -0.01 to -0.39 - Low negative correlation;
- -0.40 to -0.69 - Medium negative correlation;

- -0.70 to -0.89 - High negative correlation;
- -0.90 to -0.99 - Very high negative correlation; and
- -1.00 - Perfect negative linear association (Collis & Hussey, 2014).

4.2.3. Cohen's d

Cohen's d is used to test for a significant difference between two datasets. Therefore, it is one of the most common ways to measure effective size (Lakens, 2013). The guidelines for interpretation of results are as follows:

- Statistically significant (reject Ho) if p <= 0.05
- Practically significant if Cohen's d >= 0.20
- Interpretation levels for Cohen's d:
  - <0.20 - Not significant;
  - 0.20 – 0.49 - Small significant;
  - 0.50 – 0.79 - Medium significance; and
  - >=0.80 - Large significance (Lakens, 2013).

4.2.4. Chi-squared

The Chi-squared test is used to test patterns of outcomes or independence of association between two categorical random variables (Collis & Hussey, 2014). These patterns of outcomes are based on frequency counts. It can also be used to test across two or more populations for equality of proportions (Collis & Hussey, 2014; Wegner, 2012). Therefore, to compare a set of observed frequencies to a set of expected frequencies (Voinov et al., 2013). The Chi-squared test can be used to test for a significant difference between the correlations of the independent variables to the dependent variable (Voinov et al., 2013; Wegner, 2012).

4.3. Analysis of Results of the Engineering Survey

All the respondents who participated in this study were all students, who are currently enrolled for an engineering qualification at Nelson Mandela University, which is a Higher Education Institute located in the Eastern Cape. The respondents were requested to provide their overall experience regarding their studies in engineering. This involved why they choose to study engineering, what encouraged them the most, the challenges the female students encounter while studying engineering and their opinion towards the Faculty of Engineering in general. Therefore, a holistic view regarding the students' experience while studying engineering is provided in these combined findings.

4.3.1. Survey Response Rate

The Engineering Survey was distributed via emails containing a hyperlink to the online survey that was send to 1 716 Nelson Mandela University students studying an engineering qualification. Therefore, the population consists of 1 716 Nelson Mandela University engineering students. The number of undelivered emails is unknown, as the researcher did not have control of the emails that were distributed. In total 303 responses were received, which contained 135 female students and 168 male students who are currently registered at Nelson Mandel University in the Faculty of Engineering. As stipulated by the REC-H, the required response rate was minimum 300 and maximum 800. Therefore, the responses did exceed the minimum rate, which is necessary for the study to be viable.

4.3.2. Main Study Engineering Survey

The survey used for this study consisted of five data gathering sections. See Appendix D – Questionnaire. These sections are:
included the following:

- Section 1: Demographic Data;
- Section 2: Before Starting with Engineering Studies;
- Section 3: Experience During your Engineering Studies;
- Section 4: Most Influential People During Studies; and
- Section 5: Faculty Related Questions.

4.3.2.1. Section 1 – Demographic Data

In section 1, the demographic data, such as *Gender, Age, Ethnic group, Language, which Province they were from, which Qualification they enrolled for, Year of studies* and *whether Nelson Mandela University was their first choice of university*, were collected from the respondents. No names of the respondents were captured, in order to ensure anonymity. See Appendix F – Engineering Survey Demographic Information.

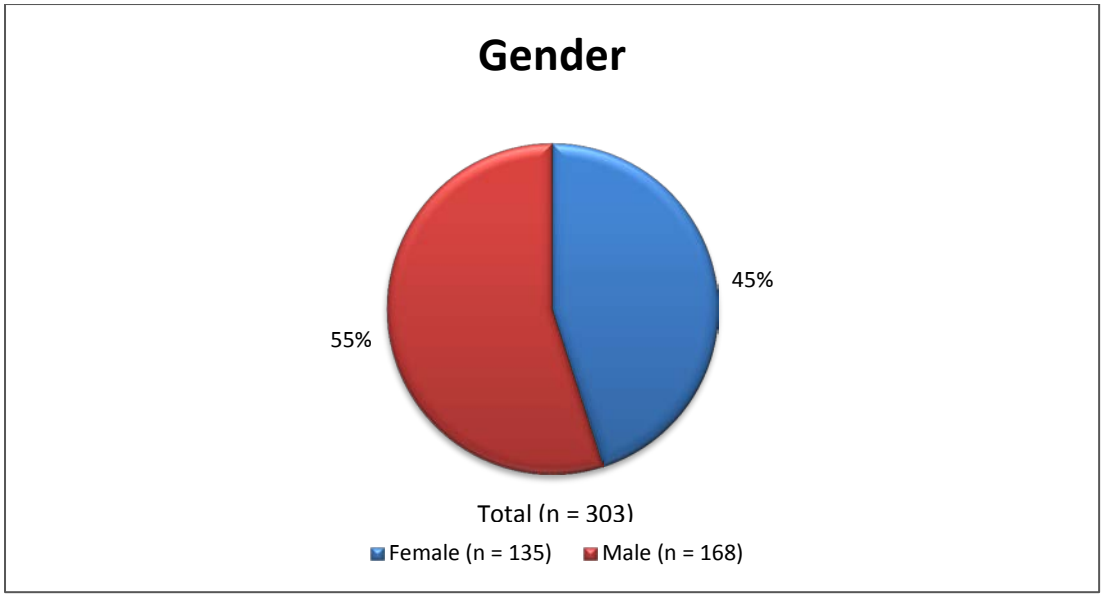

Figure 4.3: Gender

Figure 4.3 depicts the gender distribution amongst all respondents. It indicated that from all the registered students that are currently enrolled for an undergraduate qualification in the Faculty of Engineering, that participated (n = 303) in this study, 45 percent (n = 135) are female and 55 percent (n = 168) are male. As this study focussed on the engineering industry, it is well documented that it is a male dominant environment, and therefore female students are under represented (Holth, 2014; Schreuders et al., 2009).

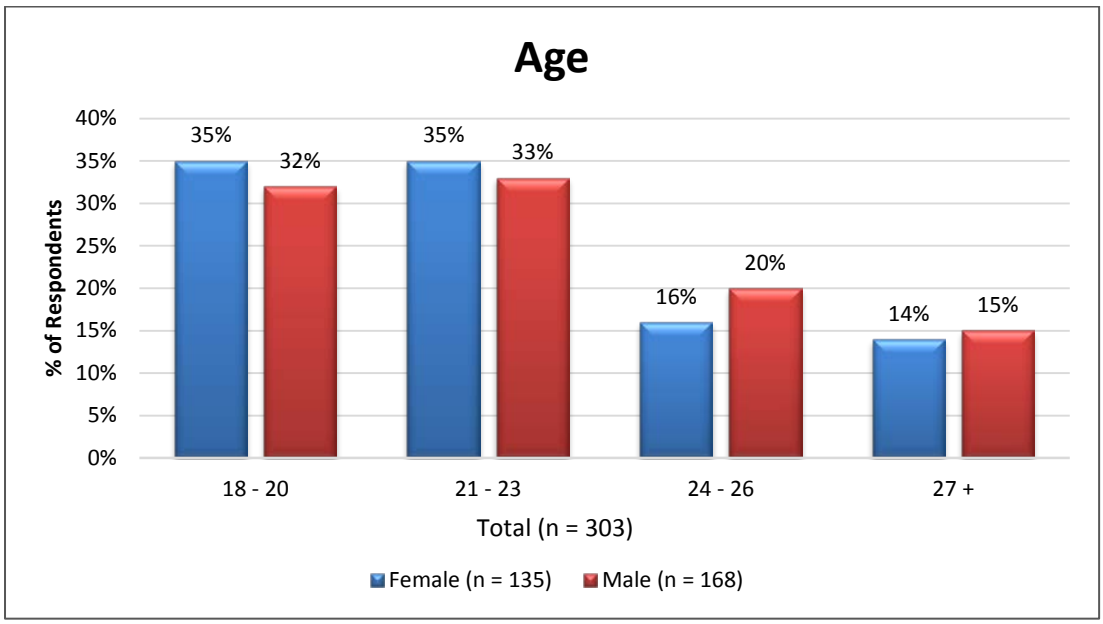

Figure 4.4: Age

Figure 4.4 depicts the responses regarding the age distribution of the respondents (n = 303) and it is divided between female (n = 135) and male (n = 168). It indicates that there are 35 percent of female students (n = 47) between the age of 18 – 20 and 32 percent of male students (n = 54) who participated in this study. Between the age of 21 – 23, there are 35 percent of female students (n = 48) and 33 percent of male students (n = 55) participated in this study. Between the age of 24 – 26, there are 16 percent of female students (n = 21) and 20 percent of male students (n = 34) participated in this study. In the age group of 27 +, there are 14 percent of female students (n = 19) and 15 percent of male students (n = 25) participated in this study.

The findings indicate that the majority of female students are primarily represented in the age groups of 18 – 20 and 21 – 23, whereas the male students are primarily represented in the age group of 21 – 23. There is a decline in respondents as their ages increase, in both female and male students.

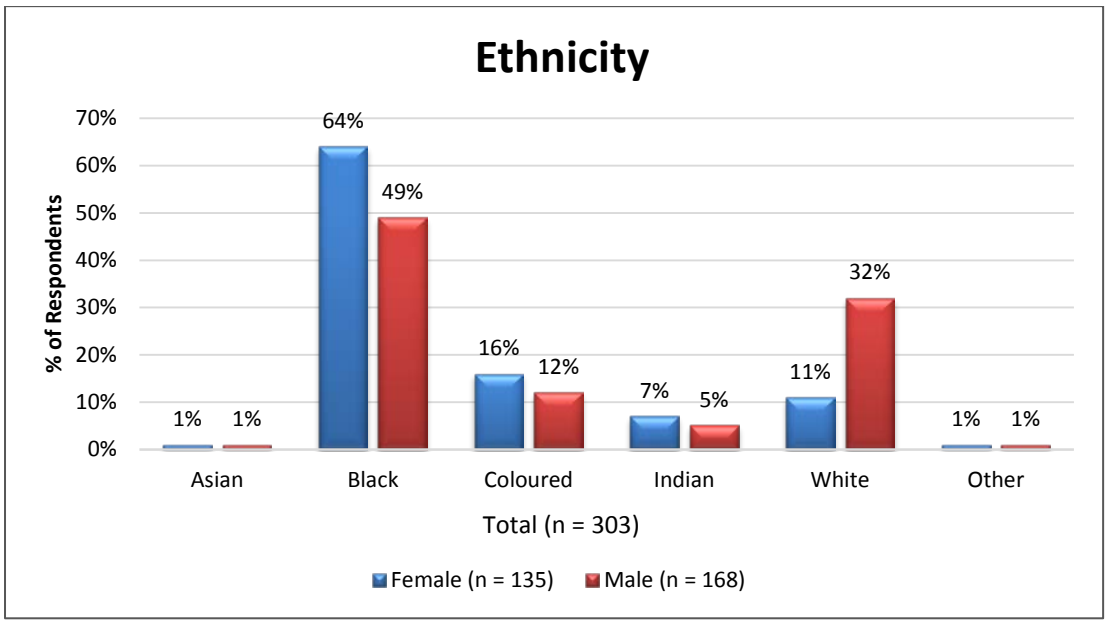

Figure 4.5: Ethnicity

Figure 4.5 depicts the responses regarding the ethnic distribution of the respondents (n = 303) and it is divided between female (n = 135) and male (n = 168). It indicates that there are 1 percent of female students (n = 1) and 1 percent of male students (n = 1) who participated in this study are Asian. Respondents who are in the Black ethnic group, indicates that 64 percent of female students (n = 86) and 49 percent of male students (n = 83) participated in this study. Respondents who are in the Coloured ethnic group, indicate that there are 16 percent of female students (n = 22) and 12 percent of male students (n =

21) participated in this study. Respondents who are in the Indian ethnic group, indicate that 7 percent of female students (n = 9) and 5 percent of male students (n = 8) participated in this study. Respondents who are in the White ethnic group, indicate that 11 percent of female students (n = 15) and 32 percent of male students (n = 54) participated in this study. Respondents who are in the Other ethnic group, indicate that 1 percent of female students (n = 2) and also 1 percent of male students (n = 1) participated in this study.

The findings indicate that the majority of both female and male students are primarily represented in the 'Black' ethnic group, whereas the minority of female and male students were represented in the 'Asian' ethnic group as well as in 'Other' ethnic group.

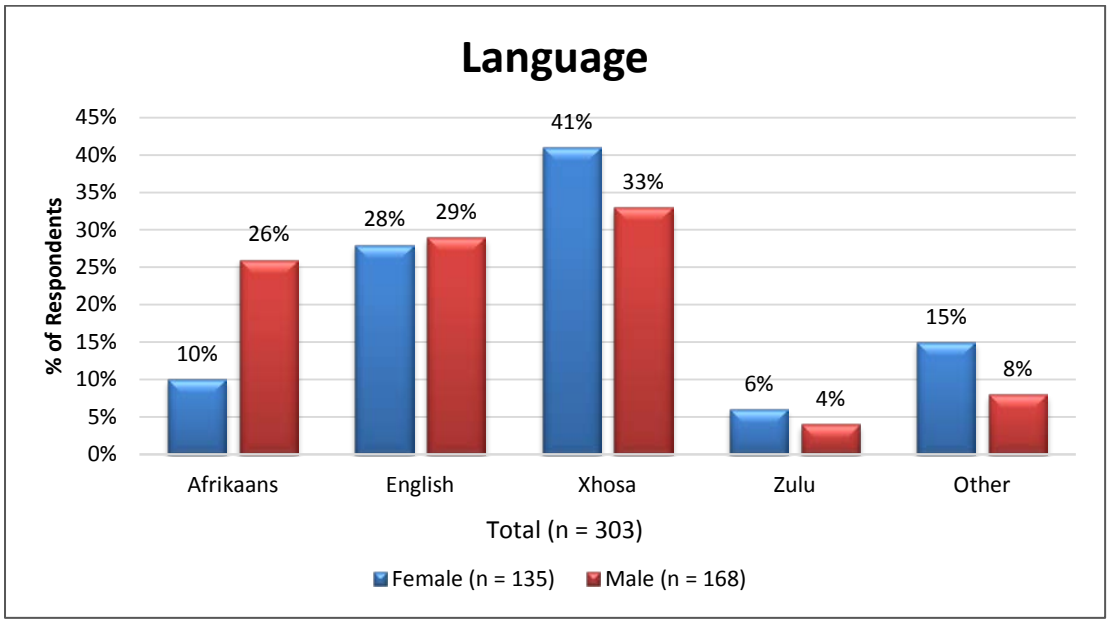

Figure 4.6: Language

Figure 4.6 indicates the responses regarding the language distribution of the respondents (n = 303) and it is divided between female (n = 135) and male (n = 168). It indicates the respondents having Afrikaans as their home language, there are 10 percent of female students (n = 13) represented and 26 percent of male students (n = 44) represented. English as their home language, there are 28 percent of female students (n = 38) representation and 29 percent of male students (n = 48) represented. Xhosa as their home language, there are 41 percent of female students (n = 56) represented and 33 percent of male students (n = 55) represented. Zulu as their home language, there are 6 percent of female students (n = 8) represented and 4 percent of male students (n = 7) represented. 'Other' as their home language, there are 15 percent of female students (n = 20) represented and 8 percent of male students (n = 14) represented.

The findings indicate that the majority of both female and male students are primarily represented with Xhosa being their home language. It indicates that the minority of both female and male students are primarily represented with Zulu being their home language. This clearly indicates that the majority of students are not English speaking. Nelson Mandela University's medium of language is English. Therefore, Nelson Mandela University needs to be aware of the diversity of languages in the classes, as some of the students may struggle with certain terminology in engineering.

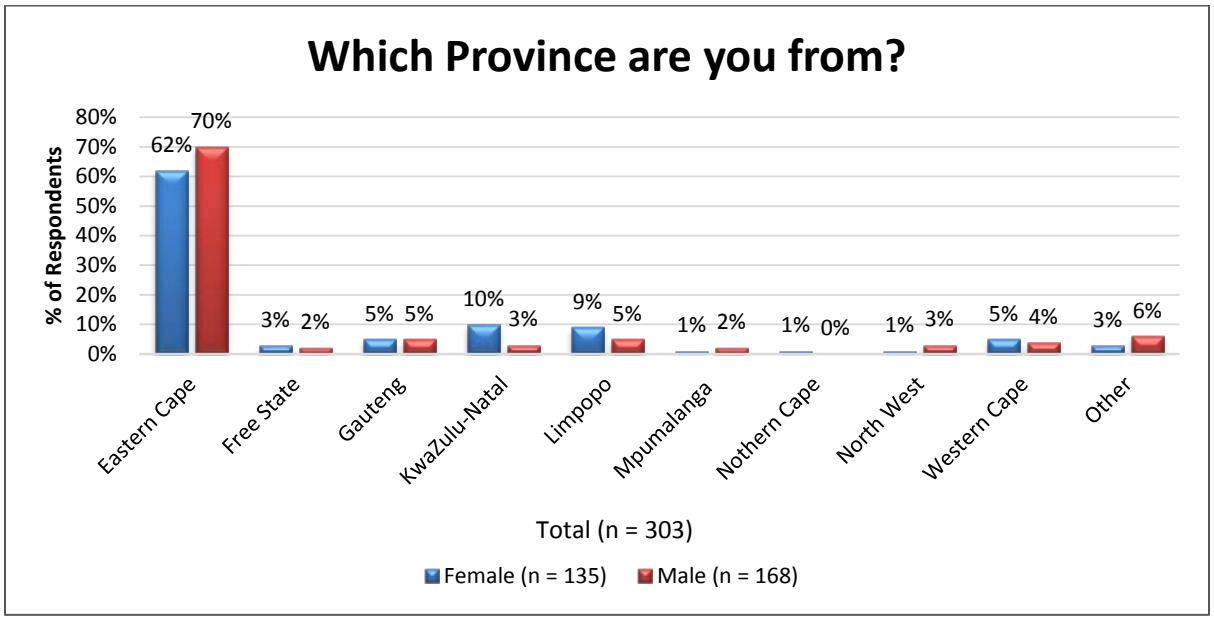

Figure 4.7: Which province are you from?

Figure 4.7 depicts the responses regarding which province the respondents (n = 303) are from and it is divided between female (n = 135) and male (n = 168). It indicates that 62 percent of female students (n = 84) are from Eastern Cape and 70 percent of male students (n = 119) are from Eastern Cape. The respondents from Free State are 3 percent of female students (n = 4) and 2 percent of male students (n = 3) are from Free State. The respondents from Gauteng are 5 percent of female students (n = 7) and 6 percent of male students (n = 9) are from Gauteng. The respondents from KwaZulu-Natal are 10 percent of female students (n = 13) and 3 percent of male students (n = 5) are from KwaZulu-Natal. The respondents from Limpopo are 9 percent of female students (n = 12) and 5 percent of male students (n = 8) are from Limpopo. The respondents from Mpumalanga are 1 percent of female students (n = 1) and 2 percent of male students (n = 3) are from Mpumalanga. The respondents from Northern Cape are 1 percent of female students (n = 2) and no male students from Northern Cape participated. The respondents from North West are 1 percent

of female students (n = 1) and 3 percent of male students (n = 5) are from Northern Cape. The respondents from Western Cape are 5 percent of female students (n = 7) and 4 percent of male students (n = 6) are from Western Cape. The respondents from 'Other' are 3 percent of female students (n = 4) and 6 percent of male students (n = 10) were from 'Other'.

The findings indicate that the majority of both female and male students are from Eastern Cape. This finding is understandable, as Nelson Mandela University is geographically situated in the Eastern Cape. There are very few students from the other provinces. The 'Other' are those students from International countries. Although there are a few students from other provinces, Nelson Mandela University must take into account that those students will encounter other challenges while studying, compared to the students living close to the university.

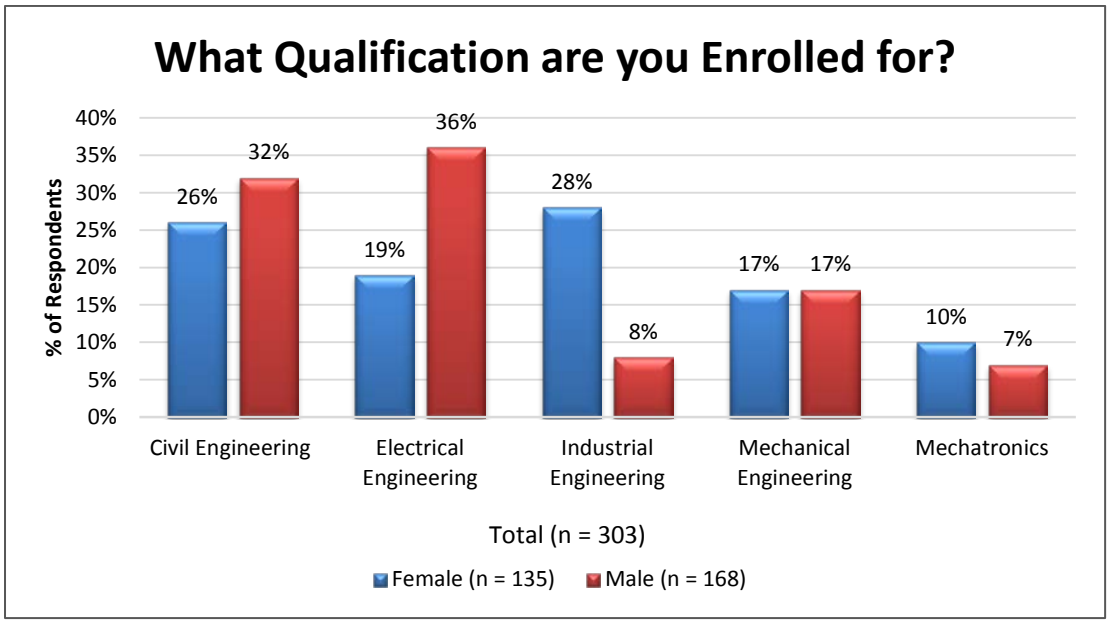

Figure 4.8: What qualification are you enrolled for?

Figure 4.8 depicts the responses regarding the qualification for which the respondents (n = 303) are enrolled. It is divided between female (n = 135) and male (n = 168). It indicates that 26 percent of female students (n = 36) and 32 percent of male students (n = 54) who participated in this study, are enrolled for Civil Engineering. There are 19 percent of female students (n = 25) and 36 percent of male students (n = 60) who participated in this study, are enrolled for Electrical Engineering. There are 28 percent of female students (n = 38) and 8 percent of male students (n = 14) who participated in this study, are enrolled for Industrial Engineering. There are 17 percent of female students (n = 23) and 17 percent of male students (n = 28) who participated in this study, are enrolled for Mechanical Engineering.

There are 10 percent of female students (n = 13) and 7 percent of male students (n = 12) who participated in this study, are enrolled for Mechatronics.

The findings indicate that the majority of female students are primarily represented in Civil Engineering and Industrial Engineering, whereas the male students are primarily represented in Electrical Engineering. The minority of both female and male students are primarily represented in Mechatronics. As indicated in chapter two, in South Africa, some of the most popular engineering qualifications are Electrical Engineering and Civil Engineering (Adams, 2015). Therefore, it makes sense that the most respondents who participated in this study, represent these two disciplines.

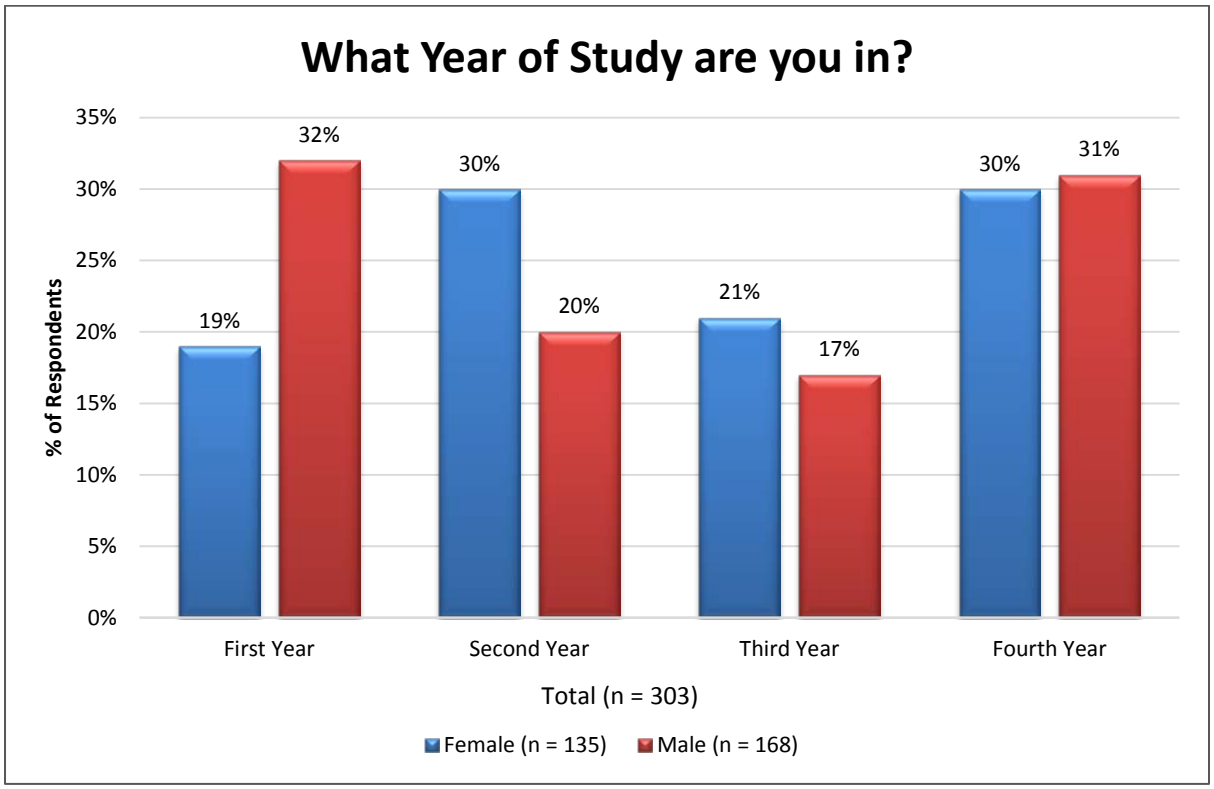

Figure 4.9: What year of study are you in?

Figure 4.9 depicts the responses regarding the year of study, which the respondents (n = 303) are in and it is divided between female (n = 135) and male (n = 168). It indicates that 19 percent of female students (n = 25) and 32 percent of male students (n = 54) are in their first year of studies. Thirty percent of female students (n = 41) and 20 percent of male students (n = 33) are in their second year of studies. Twenty-one percent of female students (n = 28) and 17 percent of male students (n = 29) are in their third year of studies. Thirty percent of female students (n = 41) and 31 percent of male students (n = 52) are in their fourth year of studies.

The findings indicate that the majority of female students are primarily represented in the second and fourth year of studies, whereas the male students are primarily represented in their first year of studies. The minority of female students were represented in their first years, whilst the minority of male students were represented in their third years.

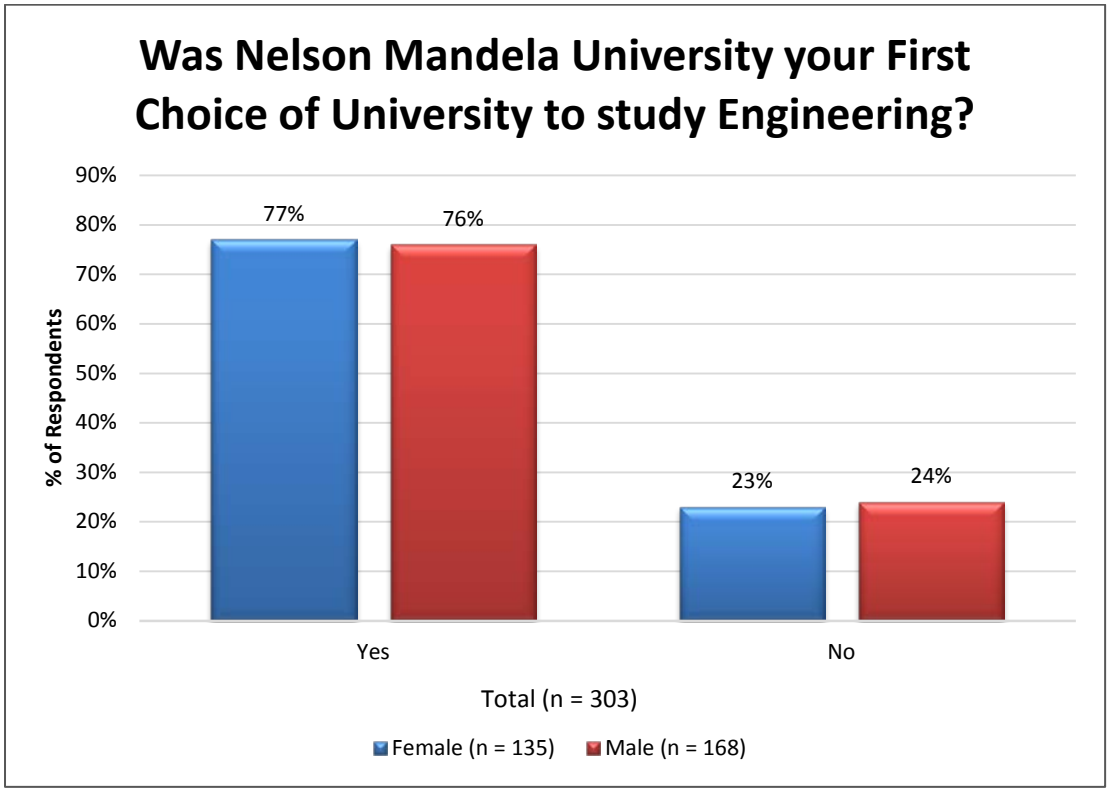

Figure 4.10: Was Nelson Mandela University your first choice of university to study Engineering?

Figure 4.10 illustrates the responses regarding whether Nelson Mandela University was the respondents (n = 303) first choice of university and it is divided between female (n = 135) and male (n = 168). It indicates that 77 percent of female students (n = 104) chose 'Yes' and 76 percent of male students (n = 127) who participated in this study chose 'Yes'. The respondents who participated in this study who indicated 'No', were 23 percent of female students (n = 31) and 24 percent of male students (n = 41).

The findings indicate that the majority of both female and male students primarily indicated that Nelson Mandela University was their first choice of university. This statement is understandable, as Nelson Mandela University is located in the Eastern Cape. The majority of respondents also indicated, as indicated in Figure 4.7, that they are located in the Eastern Cape.

The following sub-section will elaborate on the findings for Section 2 – Before Starting with Engineering Studies.

4.3.2.2. Section 2 – Before Starting with Engineering Studies

In the second section, data were captured regarding the female and male students before they started with their engineering studies. This includes when they developed an interest in engineering, why they choose to study engineering and what/who triggered this interest. Figure 4.11 – 4.13 depicts these findings.

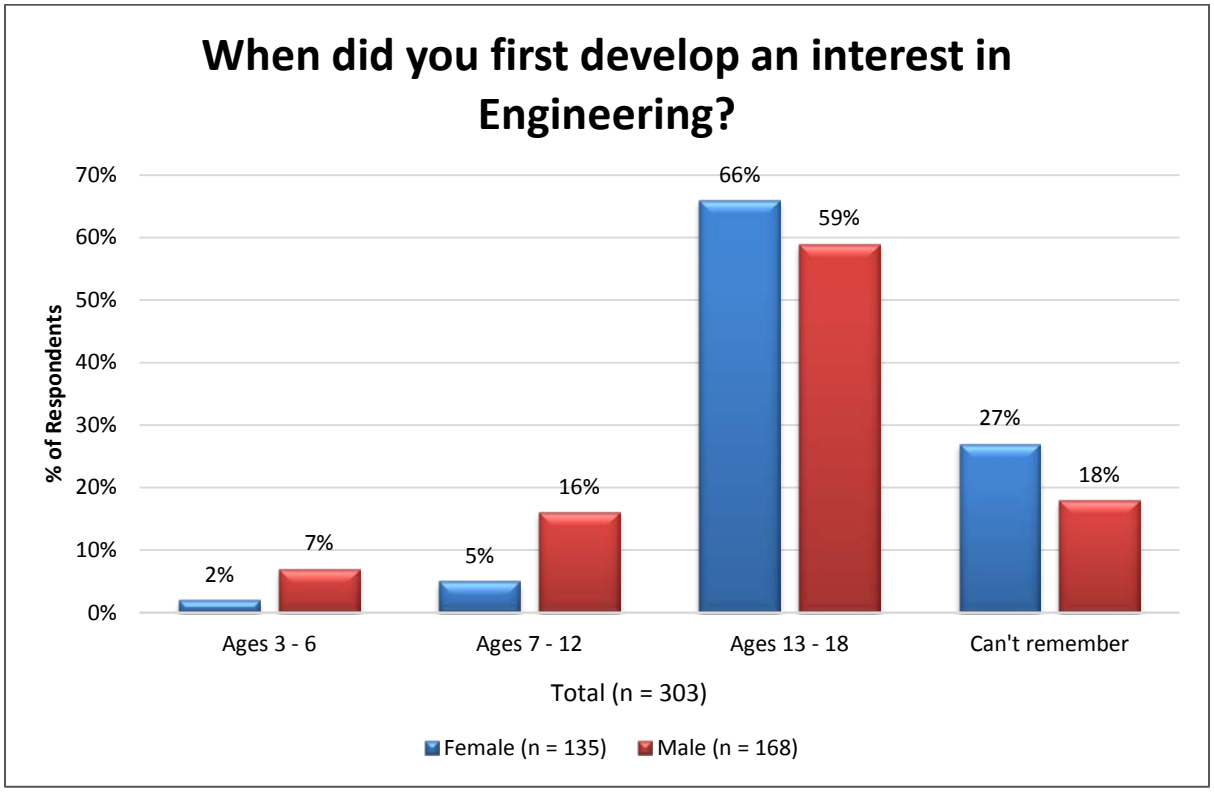

Figure 4.11: When did you first develop an interest in Engineering?

Figure 4.11 depicts the responses (n = 303) received from the female responses (n = 135) and male responses (n = 168) for the question 'When did you first develop an interest in engineering?'. Two percent (n = 3) of the female respondents indicated **'Ages 3 – 6'** and 7 percent (n = 11) of the male respondents indicated **'Ages 3 – 6'**. Five percent (n = 7) of the female respondents indicated **'Ages 7 – 12'** and 16 percent (n = 27) of the male respondents indicated **'Ages 7 – 12'**. Sixty-six percent (n = 89) of the female respondents indicated **'Ages 13 – 18'** and 59 percent (n = 99) of the male respondents indicated **'Ages 13 – 18'**. Twenty-seven percent (n = 36) of the female respondents indicated **'Cannot remember'** and 18 percent (n = 31) of the male respondents indicated **'Cannot remember'**.

The findings indicate that the majority of both female and male students first developed an interest in engineering between the ages 13 – 18. However, the minority of both female and male students indicated between the ages 3 – 6. This indicates that however, both genders developed an interest between the ages of 13 – 18. These findings are aligned with the research, namely that during school years, female students were also interested in mathematics and sciences, the same as male students. Female students also excelled in logical thinking compared to the male counterparts (Holth, 2014).

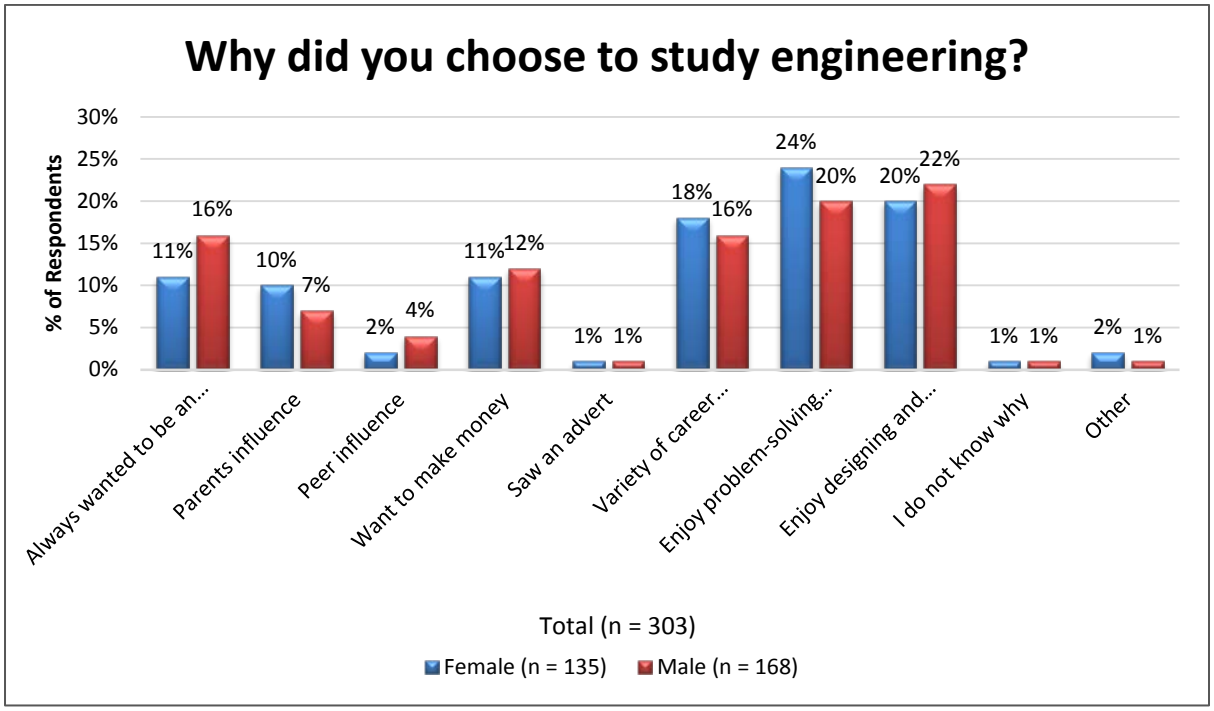

Figure 4.12: Why did you choose to study engineering?

Figure 4.12 depicts the responses (n = 303) received from the female responses (n = 135) and male responses (n = 168) for the question 'Why did you choose to study engineering?'. For this question, students could choose all relevant answers applicable to them. Eleven percent (n = 38) of the female respondents indicated **'Always wanted to be an engineer'** and 16 percent (n = 66) of the male respondents indicated **'Always wanted to be an engineer'**. Ten percent (n = 33) of the female respondents indicated **'Parents influence'** and 7 percent (n = 29) of the male respondents indicated **'Parents influence'**. Two percent (n = 5) of the female respondents indicated **'Peer influence'** and 4 percent (n = 15) of the male respondents indicated **'Peer influence'**. Eleven percent (n = 38) of the female respondents indicated **'Want to make money'** and 12 percent (n = 49) of the male respondents indicated **'Want to make money'**. One percent (n = 4) of the female respondents indicated **'Saw an advert'** and 1 percent (n = 3) of the male respondents

indicated **'Saw an advert'**. Eighteen percent (n = 60) of the female respondents indicated **'Variety of career opportunities'** and 16 percent (n = 65) of the male respondents indicated **'Variety of career opportunities'**. Twenty-four percent (n = 79) of the female respondents indicated **'Enjoy problem-solving activities'** and 20 percent (n = 80) of the male respondents indicated **'Enjoy problem-solving activities'**. Twenty percent (n = 65) of the female respondents indicated **'Enjoy designing and creating activities'** and 22 percent (n = 88) of the male respondents indicated **'Enjoy designing and creating activities'**. One percent (n = 3) of the female respondents indicated **'I do not know why'** and 1 percent (n = 2) of the male respondents indicated **'I do not know why'**. Two percent (n = 7) of the female respondents indicated **'Other'** and 1 percent (n = 5) of the male respondents indicated **'Other'**.

The findings indicate that the majority of female students enjoy problem-solving activities and secondly they enjoy designing and creating activities. The majority of male students enjoy designing and creating activities and secondly they enjoy problem-solving activities. However, the minority of both female and male students indicated that they do not know why they chose to study engineering. Therefore, there are many factors influencing women when choosing a field in engineering. This could either range from, school teachers, parents, cultural norms, social pressures (Jagacinski, 2013) or even interest in mathematics and science (Holth, 2014). Female students have a rational thinking approach when choosing a career in engineering, which involves career and job opportunities (Holth, 2014). Other reasons for studying a career in engineering may include that females are good at mathematics and science at high school level; they enjoy practical activities; they were encouraged by high school teachers; successful female role models; better social status; better job opportunities; able to apply problem solving activities to the real world; they do not mind the male- dominant environment; or simply because they enjoy engineering (Kho, 2016). However, some reasons for females not to choose a career in engineering may include that they did not do mathematics and science on high school level; perceived engineering to be a difficult field of study; perceived engineering to be too male-dominant; or that they think it would be difficult to balance work and family life (Kho, 2016).

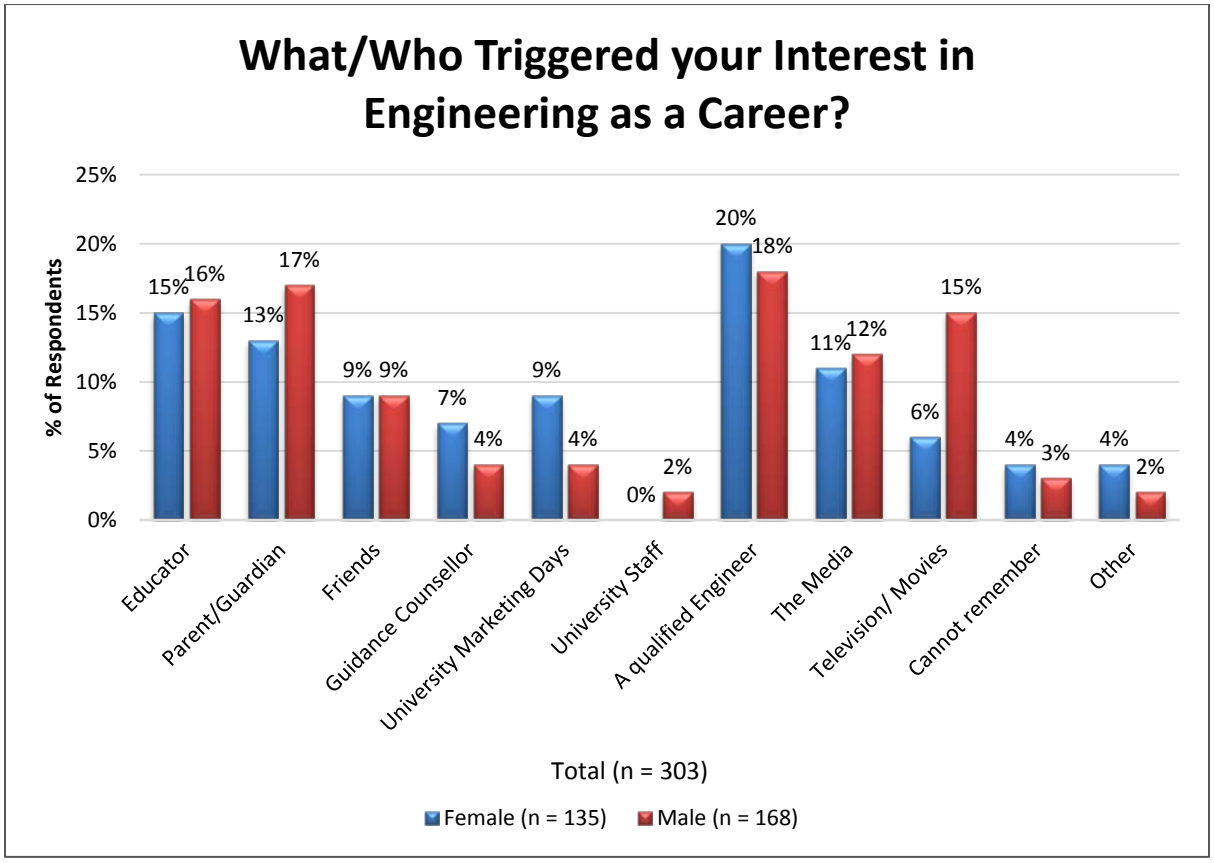

Figure 4.13: What/Who triggered your interest in engineering as a career?

Figure 4.13 depicts the responses (n = 303) received from the female responses (n = 135) and male responses (n = 168) for the question 'What/Who triggered your interest in engineering as a career?'. Fifteen percent (n = 39) of the female respondents indicated **'Educator'** and 16 percent (n = 48) of the male respondents indicated **'Educator'**. Thirteen percent (n = 33) of the female respondents indicated **'Parent/Guardian'** and 17 percent (n = 52) of the male respondents indicated **'Parent/Guardian'**. Nine percent (n = 23) of the female respondents indicated **'Friends'** and 9 percent (n = 26) of the male respondents indicated **'Friends'**. Seven percent (n = 19) of the female respondents indicated **'Guidance Counsellor'** and 4 percent (n = 11) of the male respondents indicated **'Guidance Counsellor'**. Nine percent (n = 23) of the female respondents indicated **'University Marketing Days'** and 4 percent (n = 11) of the male respondents indicated **'University Marketing Days'**. None of the female respondents indicated **'University Staff'** and 2 percent (n = 6) of the male respondents indicated **'University Staff'**. Twenty percent (n = 52) of the female respondents indicated **'A qualified Engineer'** and 18 percent (n = 54) of the male respondents indicated **'A qualified Engineer'**. Eleven percent (n = 29) of the female respondents indicated **'The Media'** and 12 percent (n = 35) of the male respondents indicated **'The Media'**. Six percent (n = 15) of the female respondents indicated

'Television/Movies' and 15 percent (n = 46) of the male respondents indicated **'Television/Movies'**. Four percent (n = 10) of the female respondents indicated **'Cannot remember'** and 3 percent (n = 8) of the male respondents indicated **'Cannot remember'**. Four percent (n = 10) of the female respondents indicated **'Other'** and 2 percent (n = 7) of the male respondents indicated **'Other'**.

The findings indicate that the majority of both female and male students indicated that a qualified engineer triggered their interest in engineering as a career. The minority of both female and male students indicated that university staff triggered their interest in engineering as a career. Therefore, the female students and male students are not different from each other when it comes to what or who triggered their interest. As the literature chapter indicated that these interests could range from school teachers, parents, cultural norms, or even social pressures (Jagacinski, 2013).

	Female (n = 135)		Male (n = 168)		Total (n = 303)	
Science, Mathematics or engineering experiences	**Female Yes**	**Female No**	**Male Yes**	**Male No**	**Total Yes**	**Total No**
Summer science, math, or engineering programmes	47% (64)	53% (71)	31% (52)	70% (117)	38% (116)	62% (188)
Competitions or contests	47% (63)	53% (72)	29% (48)	71% (120)	37% (111)	63% (192)
After-school clubs	27% (37)	73% (98)	19% (32)	81% (136)	23% (69)	77% (234)
Special programmes or workshops (on weekends, after-school)	42% (57)	58% (78)	33% (56)	67% (112)	37% (113)	63% (190)
Teaching science, maths, or engineering to others	36% (49)	64% (86)	33% (57)	67% (112)	35% (106)	65% (198)
Research experience	19% (26)	81% (109)	15% (25)	85% (143)	17% (51)	83% (252)
Paid work experience in science, maths, or engineering	8% (11)	92% (124)	8% (13)	92% (155)	8% (24)	92% (279)
Volunteer work experience	21% (29)	79% (106)	15% (26)	85% (143)	18% (55)	82% (249)

Table 4.1: Frequency count on science, mathematics, or engineering experiences during high school.

Table 4.1 indicates that the majority of female students (n = 64) indicated that they were part of summer science, mathematics or engineering programmes and they participate in competitions or contests. The majority of male students (n = 57) indicated that they were teaching science, mathematics or engineering matters to others. The majority of both female (n = 124) and male (n = 155) students indicated that they did not participate in paid work experience in science, mathematics or engineering. These findings indicate that both

female and male students indicated that they did not participate in the above items during high school. Therefore, one of the biggest issues that females face includes the differentiating socialisation factors of mathematics and physical science competencies when reaching the end of their matric year (Hartman & Hartman, 2007). However, other issues include the stereotypical threat and social pressures regarding mathematics and science. Therefore, much work needs to be done at high school level, where universities have a responsibility to support this by ongoing outreach programmes (Mills, 2011) and provide opportunities that foster creativity in engineering students (Baillie & Fitzgerald, 2000). During high school level, both females and males should be properly informed regarding the preconceived notions regarding engineering. Particularly for young girls, feelings of self-efficacy towards engineering can be experienced that can ultimately translate to lower self-confidence at a higher education institution (Johnson et al., 2013).

The following sub-section will focus on the summary of research findings in section 2.

4.3.2.3. Summary of Research Findings in Section 2

Section 2: Before Starting with Engineering Studies was used to determine the experience of both female and male students before entering Nelson Mandela University. The findings indicate that the majority of both female and male students first develop an interest in engineering during the ages of 13 – 18. The majority of both female and male students indicated that they chose to study engineering because they enjoy designing and creating activities and problem solving activities. The majority of both female and male students indicated that a qualified engineer triggered their interest in engineering. This indicates that both genders decided on engineering and choose engineering based on the same interest. Therefore, their perceptions from different genders are not different from each other.

The majority of both female and male students indicated that they did not participate in any science, mathematics or engineering activities during high school. This could result in a disadvantage for both genders regarding their high school experience with mathematics and science. As mentioned before, this may result in lower self-confidence at a higher education institution. A higher education institution will have to create extra activities in order to assist students who are poor in mathematics and science, as they will struggle with the high demand of theory and practice in each engineering qualification.

The following sub-section will elaborate on the findings for Section 3 – Experience during your Engineering Studies.

4.3.2.4. Section 3 – Experience during your Engineering Studies

This section was used to determine the experience both female and male students have during their engineering studies. Data were collected regarding whether the students were absent from the university, whether their mathematics, science and engineering abilities increased and overall experiences during their studies. Figure 4.14 – 4.31 depicts these findings.

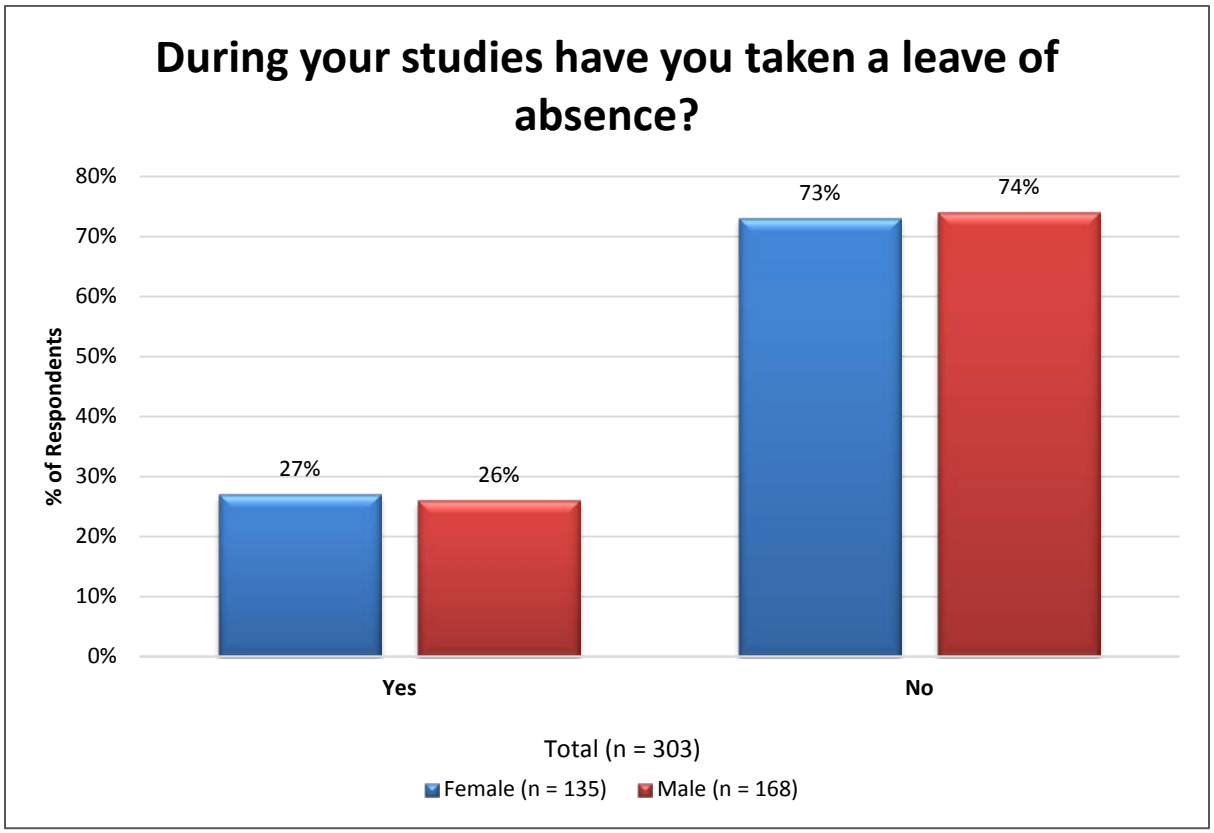

Figure 4.14: During your studies have you taken a leave of absence?

Figure 4.14 illustrates the responses regarding whether the respondents (n = 303) ever took a leave of absence from their studies. It is divided between female (n = 135) and male (n = 168). It indicates that 27 percent of female students (n = 36) indicated **'yes'** and 26 percent of male students (n = 43) who participated in this study indicated **'yes'**. The respondents who participated in this study who indicated **'no'**, are 73 percent of female students (n = 99) and 74 percent of male students (n = 125) who participated in this study indicated **'no'**.

The findings indicate that the majority of both female and male students did not take a leave of absence. This also indicates the students' commitment towards their studies.

Figures 4.15 – 4.18 depict the responses (n = 303) received from the female students (n = 135) and male students (n = 168) regarding their perception whether their confidence increased in their mathematics, science, engineering and overall academic abilities. The findings will be elaborated below.

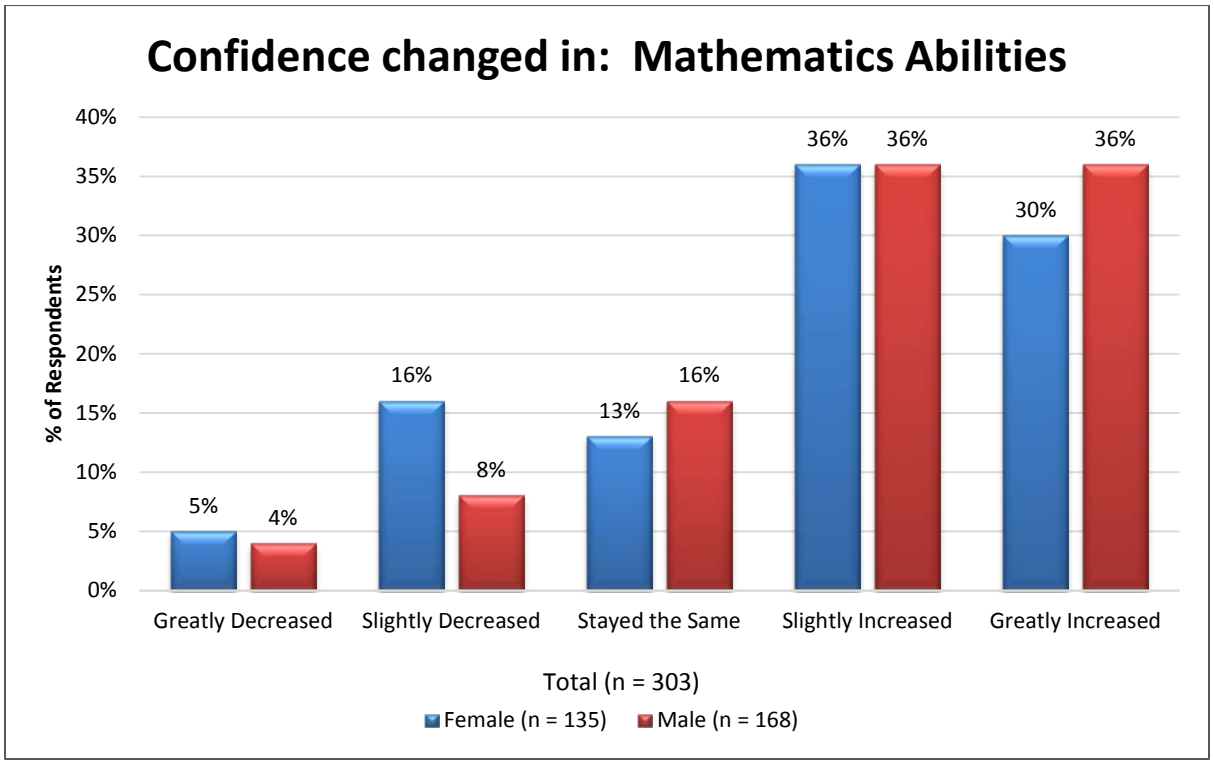

Figure 4.15: Confidence changed in: Mathematics Abilities

Figures 4.15 depicts the responses (n = 303) received from the female students (n = 135) and male students (n = 168) in the category how much the student's confidence changed in their mathematics abilities. Five percent (n = 7) of the female students indicated that their mathematics abilities **'greatly decreased'** and 4 percent (n = 7) of the male students indicated **'greatly decreased'**. Five percent of all the respondents (n = 14) indicated **'greatly decreased'**. Sixteen percent (n = 22) of the female students indicated that their mathematics abilities **'slightly decreased'** and 8 percent (n = 14) of the male students indicated **'slightly decreased'**. Twelve percent of all the respondents (n = 36) indicated **'slightly decreased'**. Thirteen percent (n = 17) of the female students indicated that their mathematics abilities **'stayed the same'** and 16 percent (n = 26) of the male students indicated **'stayed the same'**. Fourteen percent of all the respondents (n = 43) indicated **'stayed the same'**. Thirty-six percent (n = 48) of the female students indicated that their mathematics abilities **'slightly increased'** and 36 percent (n = 61) of the male students indicated **'slightly increased'**. Thirty-six percent of all the respondents (n = 109) indicated

'slightly increased'. Thirty percent (n = 41) of the female students indicated that their mathematics abilities **'greatly increased'** and 36 percent (n = 60) of the male students indicated **'greatly increased'**. Thirty-three percent of all the respondents (n = 101) indicated **'greatly increased'**.

The findings indicate that the majority of both female and male students' abilities in mathematics increased since they attended the university. The minority of students indicated that their mathematics abilities greatly decreased.

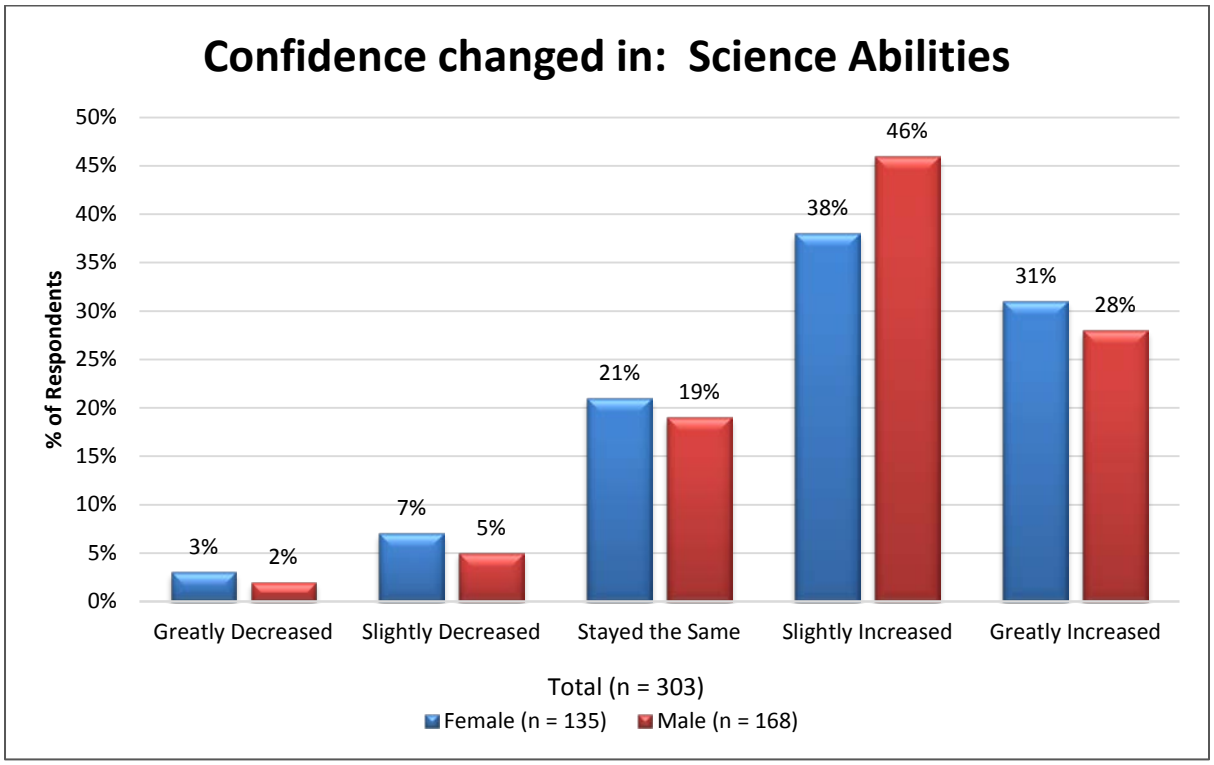

Figure 4.16: Confidence changed in: Science Abilities

Figures 4.16 depicts the responses (n = 303) received from the female students (n = 135) and male students (n = 168) in the category how much the student's confidence changed in their science abilities. Three percent (n = 4) of the female students indicated that their science abilities **'greatly decreased'** and 2 percent (n = 3) of the male students indicated **'greatly decreased'**. Two percent of all the respondents (n = 7) indicated **'greatly decreased'**. Seven percent (n = 10) of the female students indicated that their science abilities **'slightly decreased'** and 5 percent (n = 9) of the male students indicated **'slightly decreased'**. Six percent of all the respondents (n = 19) indicated **'slightly decreased'**. Twenty-one percent (n = 28) of the female students indicated that their science abilities **'stayed the same'** and 19 percent (n = 31) of the male students indicated **'stayed the**

same'. Nineteen percent of all the respondents (n = 59) indicated **'stayed the same'**. Thirty-eight percent (n = 51) of the female students indicated that their science abilities **'slightly increased'** and 46 percent (n = 78) of the male students indicated **'slightly increased'**. Forty-three percent of all the respondents (n = 129) indicated **'slightly increased'**. Thirty-one percent (n = 42) of the female students indicated that their science abilities **'greatly increased'** and 28 percent (n = 47) of the male students indicated **'greatly increased'**. Twenty-nine percent of all the respondents (n = 89) indicated **'greatly increased'**.

The findings indicate that the majority of both female and male students' abilities in science slightly increased since they attended the university. The minority of students indicated that their science abilities decreased greatly.

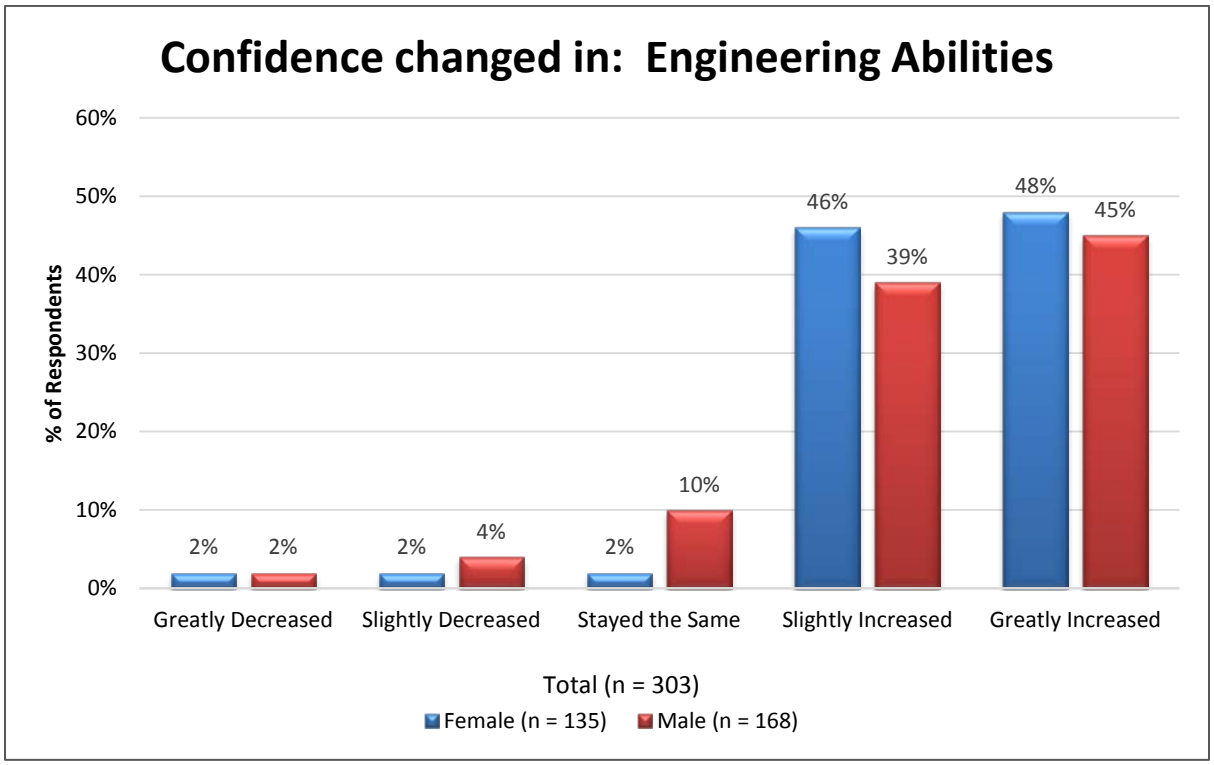

Figure 4.17: Confidence changed in: Engineering Abilities

Figures 4.17 depicts the responses (n = 303) received from the female students (n = 135) and male students (n = 168) in the category how much the student's confidence changed in their engineering abilities. Two percent (n = 4) of the female students indicated that their engineering abilities **'greatly decreased'** and 2 percent (n = 2) of the male students indicated **'greatly decreased'**. Two percent of all the respondents (n = 6) indicated **'greatly decreased'**. Two percent (n = 3) of the female students indicated that their engineering

abilities **'slightly decreased'** and 4 percent (n = 7) of the male students indicated **'slightly decreased'**. Three percent of all the respondents (n = 10) indicated **'slightly decreased'**. Two percent (n = 3) of the female students indicated that their engineering abilities **'stayed the same'** and 10 percent (n = 16) of the male students indicated **'stayed the same'**. Six percent of all the respondents (n = 19) indicated **'stayed the same'**. Forty-six percent (n = 61) of the female students indicated that their engineering abilities **'slightly increased'** and 39 percent (n = 66) of the male students indicated **'slightly increased'**. Forty-two percent of all the respondents (n = 127) indicated **'slightly increased'**. Forty-eight percent (n = 65) of the female students indicated that their engineering abilities **'greatly increased'** and 45 percent (n = 76) of the male students indicated **'greatly increased'**. Forty-seven percent of all the respondents (n = 141) indicated **'greatly increased'**.

The findings indicate that the majority of both female and male students' abilities in engineering significantly increased since they attended the university. The minority of students indicated that their engineering abilities decreased greatly.

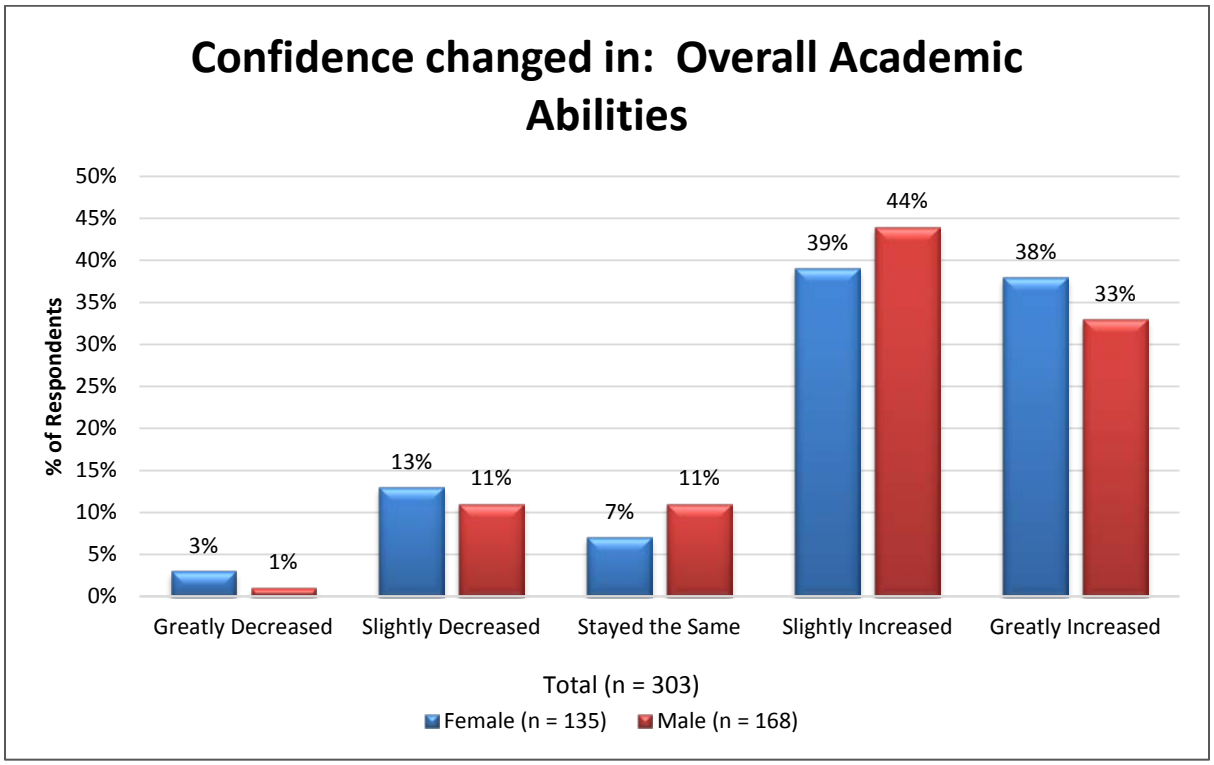

Figure 4.18: Confidence changed in: Overall Academic Abilities

Figures 4.18 depicts the responses (n = 303) received from the female students (n = 135) and male students (n = 168) in the category how much the student's confidence changed in their overall academic abilities. Three percent (n = 4) of the female students indicated that

their overall academic abilities **'greatly decreased'** and 1 percent (n = 2) of the male students indicated **'greatly decreased'**. Two percent of all the respondents (n = 6) indicated **'greatly decreased'**. Thirteen percent (n = 18) of the female students indicated that their overall academic abilities **'slightly decreased'** and 11 percent (n = 19) of the male students indicated **'slightly decreased'**. Twelve percent of all the respondents (n = 37) indicated **'slightly decreased'**. Seven percent (n = 9) of the female students indicated that their overall academic abilities **'stayed the same'** and 11 percent (n = 19) of the male students indicated **'stayed the same'**. Nine percent of all the respondents (n = 28) indicated **'stayed the same'**. Thirty-nine percent (n = 53) of the female students indicated that their overall academic abilities **'slightly increased'** and 44 percent (n = 73) of the male students indicated **'slightly increased'**. Forty-two percent of all the respondents (n = 126) indicated **'slightly increased'**. Thirty-eight percent (n = 51) of the female students indicated that their overall academic abilities **'greatly increased'** and 33 percent (n = 55) of the male students indicated **'greatly increased'**. Thirty-five percent of all the respondents (n = 106) indicated **'greatly increased'**.

The findings indicate that the majority of both female and male students' overall academic abilities slightly increased since they attended the university. The minority of students indicated that their overall academic abilities decreased greatly.

Test: Correlations between the different abilities gained at the university						
	Means	Std. Dev.	Maths abilities	Science abilities	Engineering abilities	Overall academic abilities
Maths abilities	3.82	1.16	1.000	0.646	0.562	0.550
Science abilities	3.90	0.97	0.646	1.000	0.590	0.511
Engineering abilities	4.28	0.87	0.562	0.590	1.000	0.571
Overall academic abilities	3.95	1.05	0.550	0.511	0.571	1.000

Table 4.2: Correlations between the different abilities gained at the university

Table 4.2 indicates a medium positive correlation between the different variables. Thus, there is a positive relationship between the student's mathematics, science, engineering and overall academic abilities. $p < .0005$ which indicates that a statistical, significant relationship exists between the different variables. The Cronbach Alpha for this construct was established as 0.84 indicating moderate reliability.

Variable	T-tests; Grouping: Gender								
	Mean (1)	Mean (2)	t-value	df	p	Valid N (1)	Valid N (2)	Std Dev. (1)	Std Dev. (2)
Readiness	3.96667	4.00446	-0.3907	301	0.6962	135	168	0.8452	0.83004

Table 4.3: T-tests on Gender with Readiness variables

Table 4.3 indicates a t-test conducted on gender with the readiness variables. This clearly specifies that p>0.05, which indicates that there is no significant difference between female and male students, as the mean for both students is four. Thus, most female and male students indicated 'slightly increased' on the questionnaire.

Figures 4.19 – 4.24 depicts both female and male students' perception regarding their studies and whether they deliver excellent work to the best of their abilities. The findings will be elaborated below.

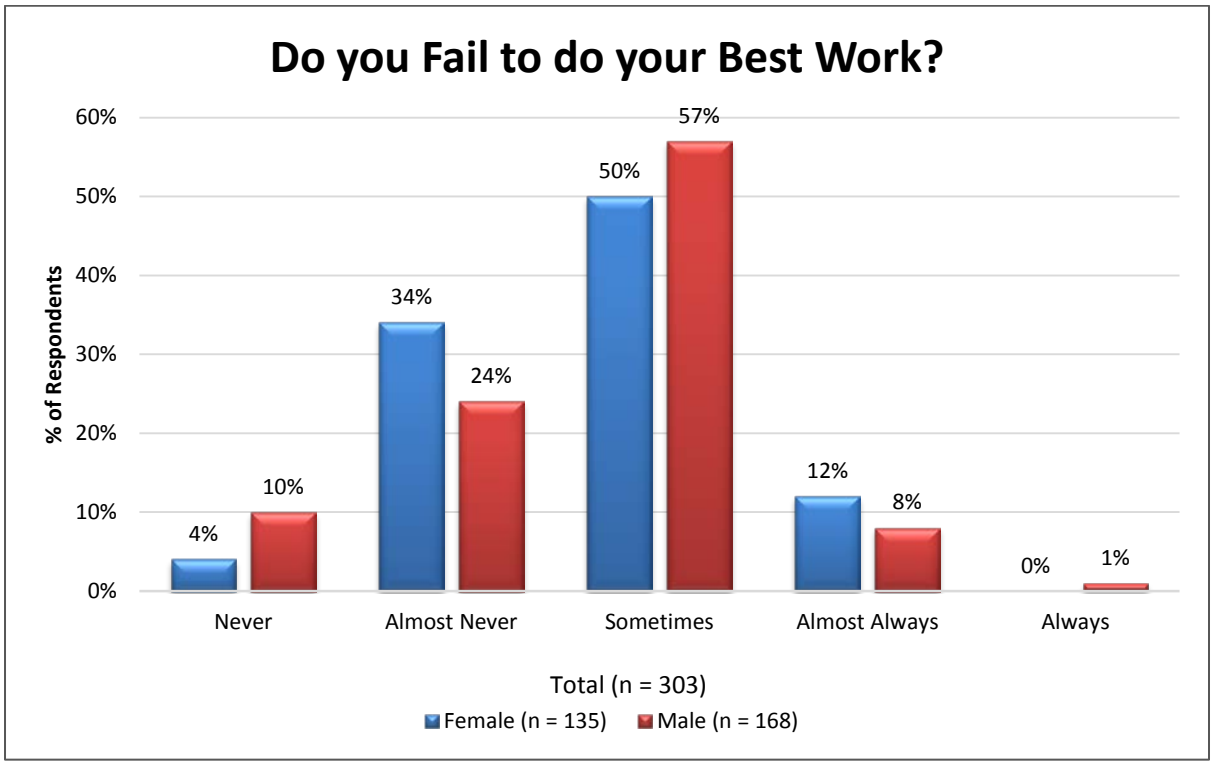

Figure 4.19: Do you fail to do your best work?

Figure 4.19 depicts the responses (n = 303) received from the female responses (n = 135) and male responses (n = 168) on the statement 'Do you fail to do your best work?'. Four percent (n = 5) of the female respondents indicated **'Never'** and 10 percent (n = 16) of the male respondents indicated **'Never'**. Thirty-four percent (n = 46) of the female respondents indicated **'Almost Never'** and 24 percent (n = 40) of the male respondents indicated **'Almost Never'**. Fifty percent (n = 67) of the female respondents indicated **'Sometimes'**

and 57 percent (n = 97) of the male respondents indicated **'Sometimes'**. Twelve percent (n = 17) of the female respondents indicated **'Almost Always'** and 8 percent (n = 14) of the male respondents indicated **'Almost Always'**. None of the female respondents indicated **'Always'** and 1 percent (n = 1) of the male respondents indicated **'Always'**.

The findings indicate that the majority of both female and male students indicated that they sometimes fail to do their best work. However, the minority of both female and male students indicated that they always fail to do their best work.

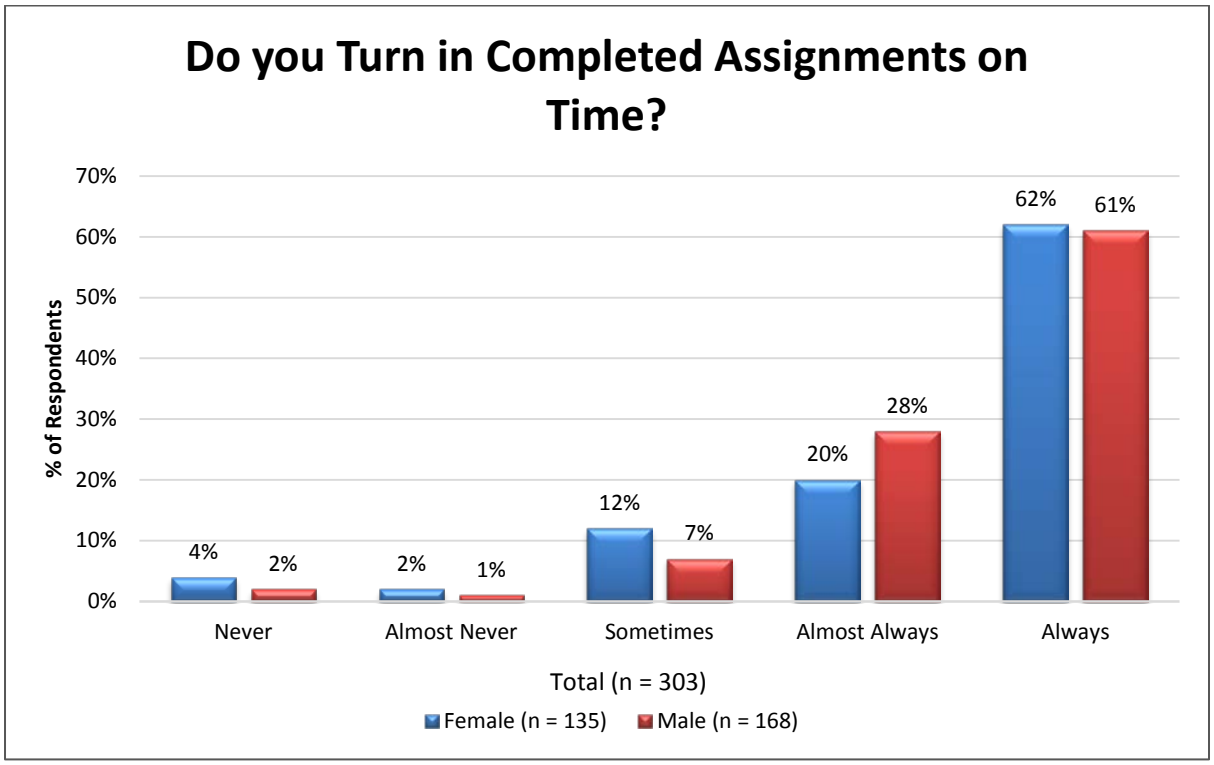

Figure 4.20: Do you turn in completed assignments on time?

Figure 4.20 depicts the responses (n = 303) received from the female responses (n = 135) and male responses (n = 168) on the statement 'Do you turn in completed assignments on time?'. Four percent (n = 6) of the female respondents indicated **'Never'** and 2 percent (n = 4) of the male respondents indicated **'Never'**. Two percent (n = 2) of the female respondents indicated **'Almost Never'** and 1 percent (n = 2) of the male respondents indicated **'Almost Never'**. Twelve percent (n = 16) of the female respondents indicated **'Sometimes'** and 7 percent (n = 12) of the male respondents indicated **'Sometimes'**. Twenty percent (n = 27) of the female respondents indicated **'Almost Always'** and 28 percent (n = 47) of the male respondents indicated **'Almost Always'**. Sixty-two percent (n =

84) of the female respondents indicated **'Always'** and 61 percent (n = 103) of the male respondents indicated **'Always'**.

The findings indicate that the majority of both female and male students indicated that they always turn in completed assignments on time. However, the minority of both female and male students indicated that they almost never turn in completed assignments on time.

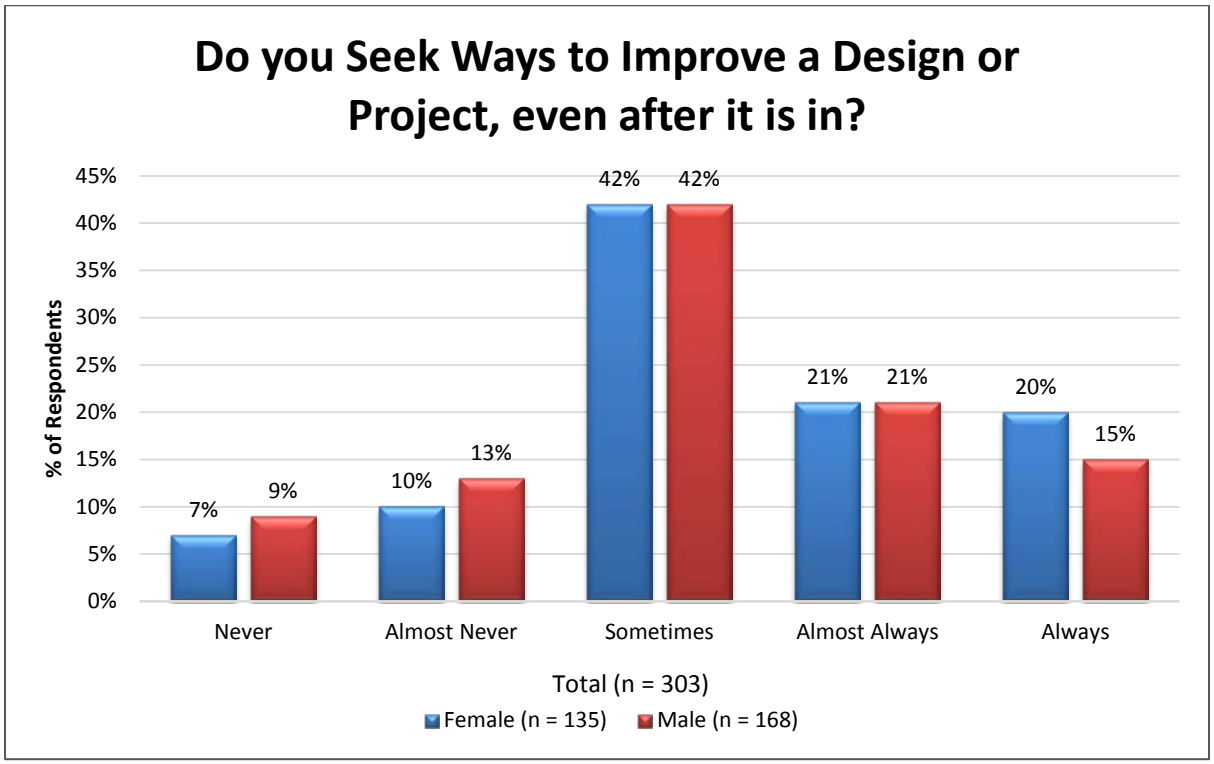

Figure 4.21: Do you seek ways to improve a design or project, even after it is in?

Figure 4.21 depicts the responses (n = 303) received from the female responses (n = 135) and male responses (n = 168) on the statement 'Do you seek ways to improve a design or project, even after it is in?'. Seven percent (n = 9) of the female respondents indicated **'Never'** and 9 percent (n = 15) of the male respondents indicated **'Never'**. Ten percent (n = 14) of the female respondents indicated **'Almost Never'** and 13 percent (n = 21) of the male respondents indicated **'Almost Never'**. Forty-two percent (n = 56) of the female respondents indicated **'Sometimes'** and 42 percent (n = 70) of the male respondents indicated **'Sometimes'**. Twenty-one percent (n = 29) of the female respondents indicated **'Almost Always'** and 21 percent (n = 36) of the male respondents indicated **'Almost Always'**. Twenty percent (n = 27) of the female respondents indicated **'Always'** and 15 percent (n = 26) of the male respondents indicated **'Always'**.

The findings indicate that the majority of both female and male students indicated that they sometimes improve their designs or projects, even after it has been submitted. However, the minority of both female and male students indicated that they never improve their designs or projects, even after it has been submitted.

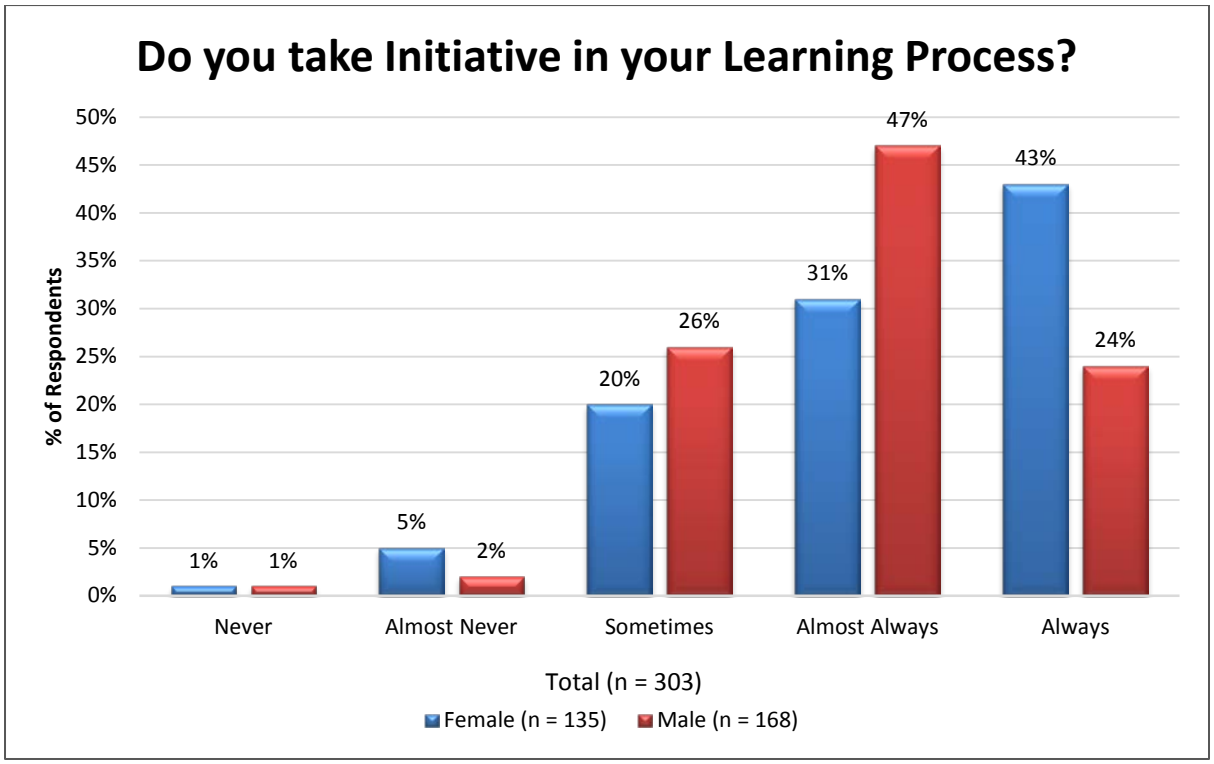

Figure 4.22: Do you take initiative in your learning process?

Figure 4.22 depicts the responses (n = 303) received from the female responses (n = 135) and male responses (n = 168) on the statement 'Do you take initiative in your learning process?'. One percent (n = 1) of the female respondents indicated **'Never'** and 1 percent (n = 1) of the male respondents indicated **'Never'**. Five percent (n = 7) of the female respondents indicated **'Almost Never'** and 2 percent (n = 4) of the male respondents indicated **'Almost Never'**. Twenty percent (n = 27) of the female respondents indicated **'Sometimes'** and 26 percent (n = 44) of the male respondents indicated **'Sometimes'**. Thirty-one percent (n = 42) of the female respondents indicated **'Almost Always'** and 47 percent (n = 78) of the male respondents indicated **'Almost Always'**. Forty-three percent (n = 58) of the female respondents indicated **'Always'** and 24 percent (n = 41) of the male respondents indicated **'Always'**.

The findings indicate that the majority of female students indicated that they always take initiative in their learning process and the majority of male students indicated that they

almost always take initiative in their learning process. However, the minority of both female and male students indicated that they never take initiative in their learning process.

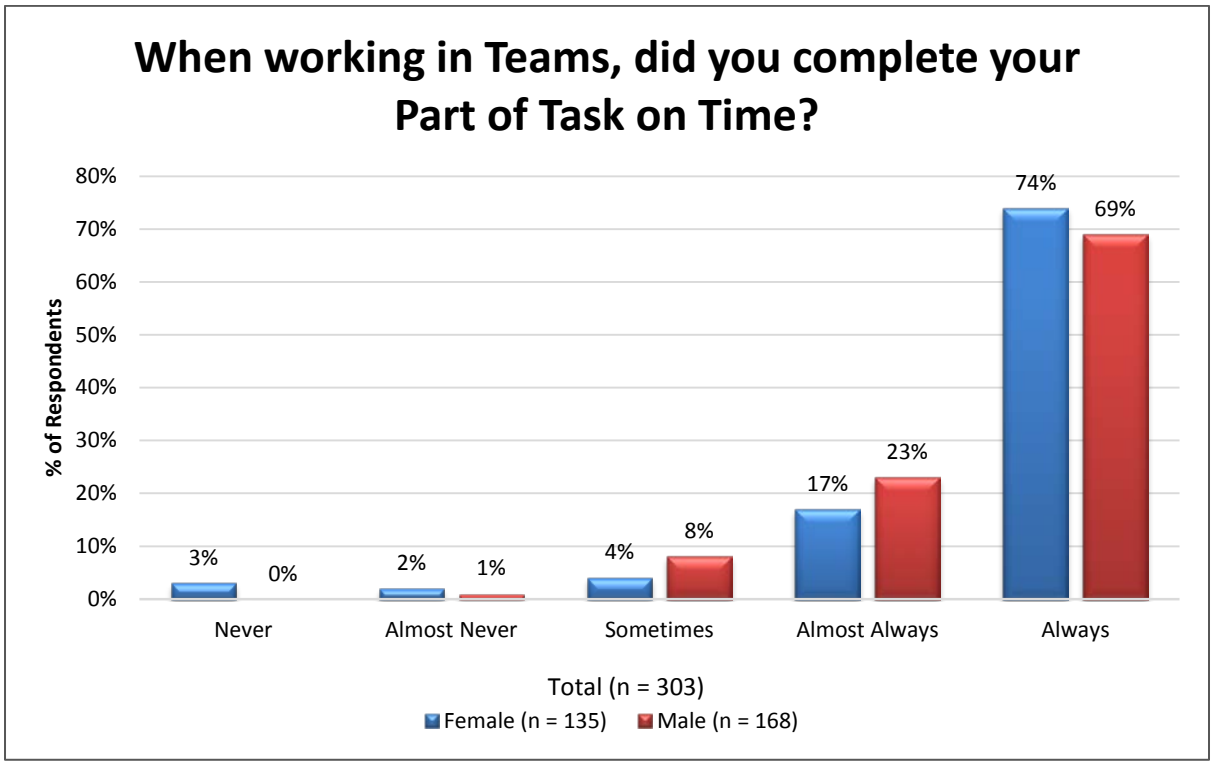

Figure 4.23: When working in teams, did you complete your part of task on time?

Figure 4.23 depicts the responses (n = 303) received from the female responses (n = 135) and male responses (n = 168) on the statement 'When working in teams, did you complete your part of the task on time?'. Three percent (n = 4) of the female respondents indicated **'Never'** and none of the male respondents indicated **'Never'**. Two percent (n = 2) of the female respondents indicated **'Almost Never'** and 1 percent (n = 1) of the male respondents indicated **'Almost Never'**. Four percent (n = 5) of the female respondents indicated **'Sometimes'** and 8 percent (n = 13) of the male respondents indicated **'Sometimes'**. Seventeen percent (n = 24) of the female respondents indicated **'Almost Always'** and 23 percent (n = 38) of the male respondents indicated **'Almost Always'**. Seventy-four percent (n = 100) of the female respondents indicated **'Always'** and 69 percent (n = 116) of the male respondents indicated **'Always'**.

The findings indicate that the majority of both female and male students indicated that they always complete their part of the task on time, when working in teams. However, the minority of female students indicated that they almost never complete their part of the task

on time, when working in teams and male students indicated that they never complete their part of the task in time, when working in teams.

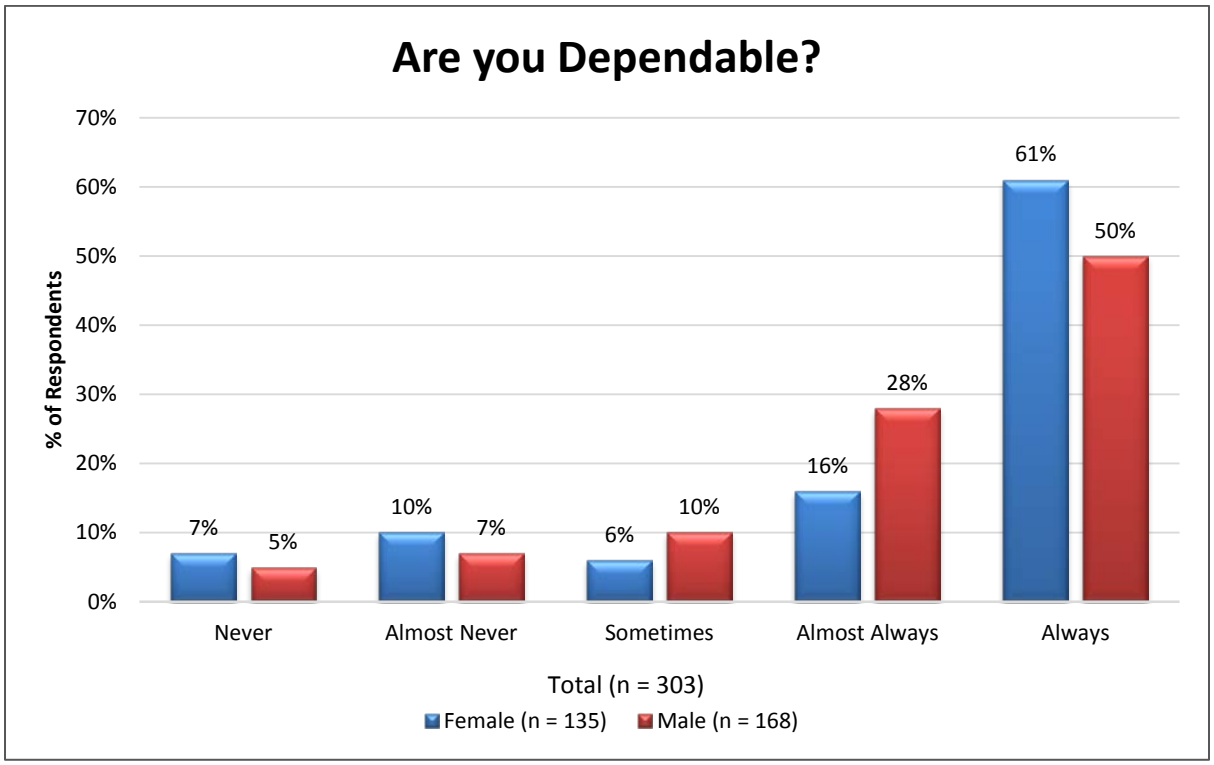

Figure 4.24: Are you dependable?

Figure 4.24 depicts the responses (n = 303) received from the female responses (n = 135) and male responses (n = 168) on the statement 'Are you dependable?'. Seven percent (n = 9) of the female respondents indicated **'Never'** and 5 percent (n = 8) of the male respondents indicated **'Never'**. Ten percent (n = 13) of the female respondents indicated **'Almost Never'** and 7 percent (n = 11) of the male respondents indicated **'Almost Never'**. Six percent (n = 8) of the female respondents indicated **'Sometimes'** and 10 percent (n = 17) of the male respondents indicated **'Sometimes'**. Sixteen percent (n = 22) of the female respondents indicated **'Almost Always'** and 28 percent (n = 48) of the male respondents indicated **'Almost Always'**. Sixty-one percent (n = 83) of the female respondents indicated **'Always'** and 50 percent (n = 84) of the male respondents indicated **'Always'**.

The findings indicate that the majority of both female and male students indicated that they are always dependable. However, the minority of female students indicated that they are sometimes dependable and male students indicated that they are never dependable.

Figures 4.25 – 4.30 depict the level of agreement for both female and male students regarding their experience during their studies. The findings will be elaborated below.

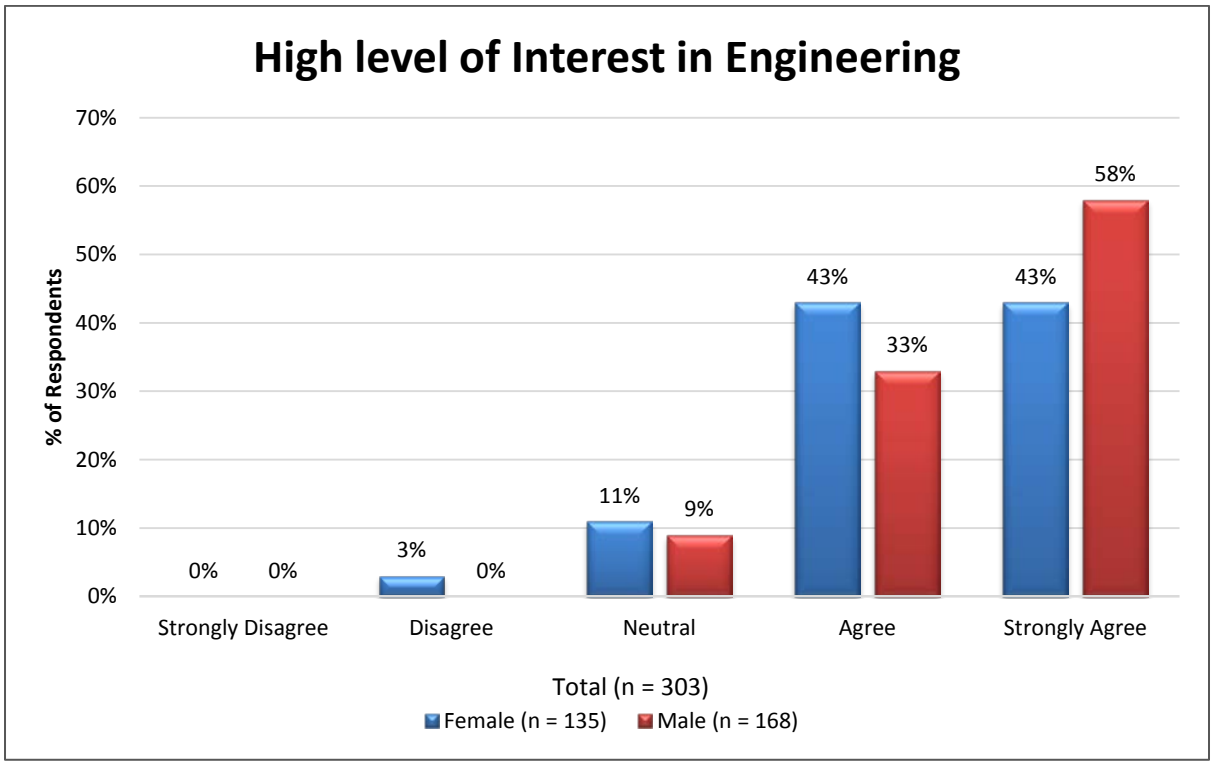

Figure 4.25: High level of interest in engineering.

Figure 4.25 depicts the responses (n = 303) received from the female responses (n = 135) and male responses (n = 168) for their opinion on 'I have a high level of interest in engineering'. None of the female and male respondents indicated **'Strongly Disagree'**. Three percent (n = 4) of the female respondents indicated **'Disagree'** and none of the male respondents indicated **'Disagree'**. Eleven percent (n = 15) of the female respondents indicated **'Neutral'** and 9 percent (n = 15) of the male respondents indicated **'Neutral'**. Forty-three percent (n = 58) of the female respondents indicated **'Agree'** and 33 percent (n = 55) of the male respondents indicated **'Agree'**. Forty-three percent (n = 58) of the female respondents indicated **'Strongly Agree'** and 58 percent (n = 98) of the male respondents indicated **'Strongly Agree'**.

The findings indicate that the majority of both female and male students strongly agree that they have a high level of interest in engineering. However, the minority of both female and male students strongly disagree with this statement. Therefore, this is aligned with the literature chapter that women are becoming more interested in a career in engineering, although it is largely a male-dominated career (Holth, 2014).

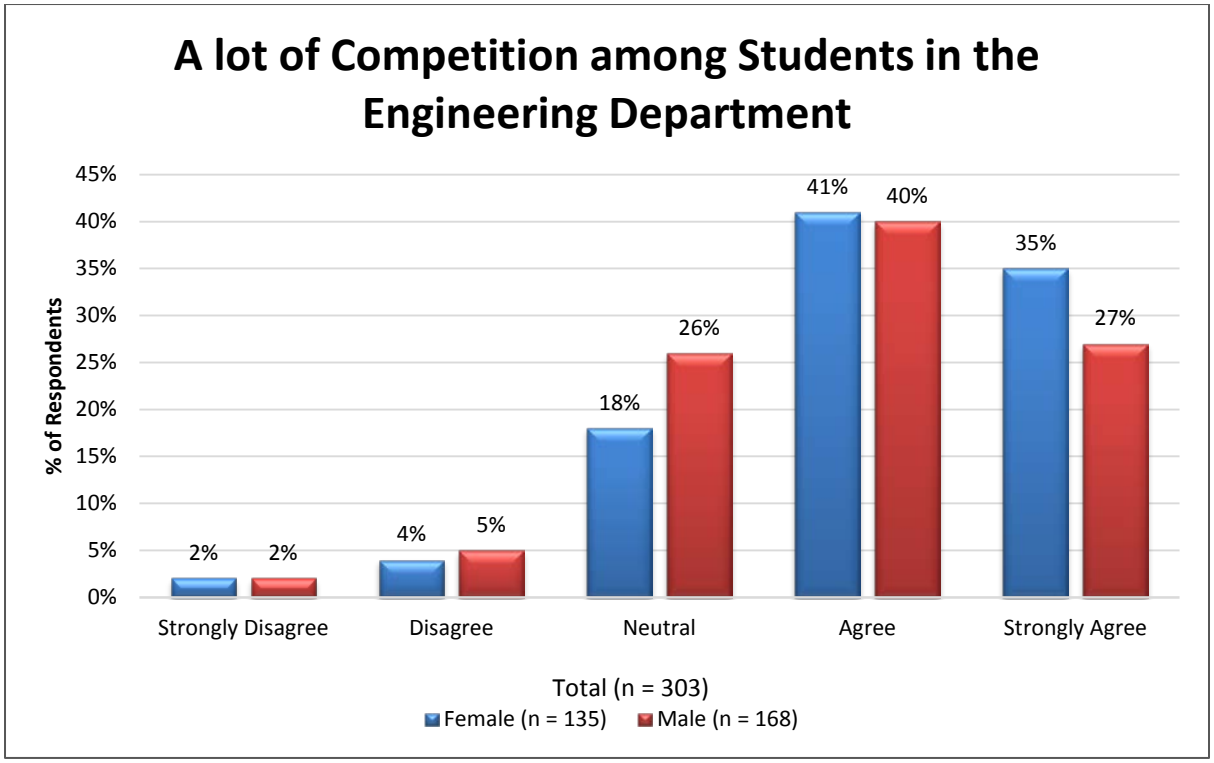

Figure 4.26: A lot of competition among students in the Engineering Department.

Figure 4.26 depicts the responses (n = 303) received from the female responses (n = 135) and male responses (n = 168) for their opinion on 'I feel there is a lot of competition (among students) in the engineering department'. Two percent (n = 4) of the female respondents indicated **'Strongly Disagree'** and 2 percent (n = 2) of the male respondents indicated **'Strongly Disagree'**. Four percent (n = 6) of the female respondents indicated **'Disagree'** and 5 percent (n = 8) of the male respondents indicated **'Disagree'**. Eighteen percent (n = 24) of the female respondents indicated **'Neutral'** and 26 percent (n = 44) of the male respondents indicated **'Neutral'**. Forty-one percent (n = 55) of the female respondents indicated **'Agree'** and 40 percent (n = 67) of the male respondents indicated **'Agree'**. Thirty-five percent (n = 48) of the female respondents indicated **'Strongly Agree'** and 27 percent (n = 46) of the male respondents indicated **'Strongly Agree'**.

The findings indicate that the majority of both female and male students agree that they feel there is a lot of competition among students in the engineering department. However, the minority of both female and male students strongly disagree with this statement.

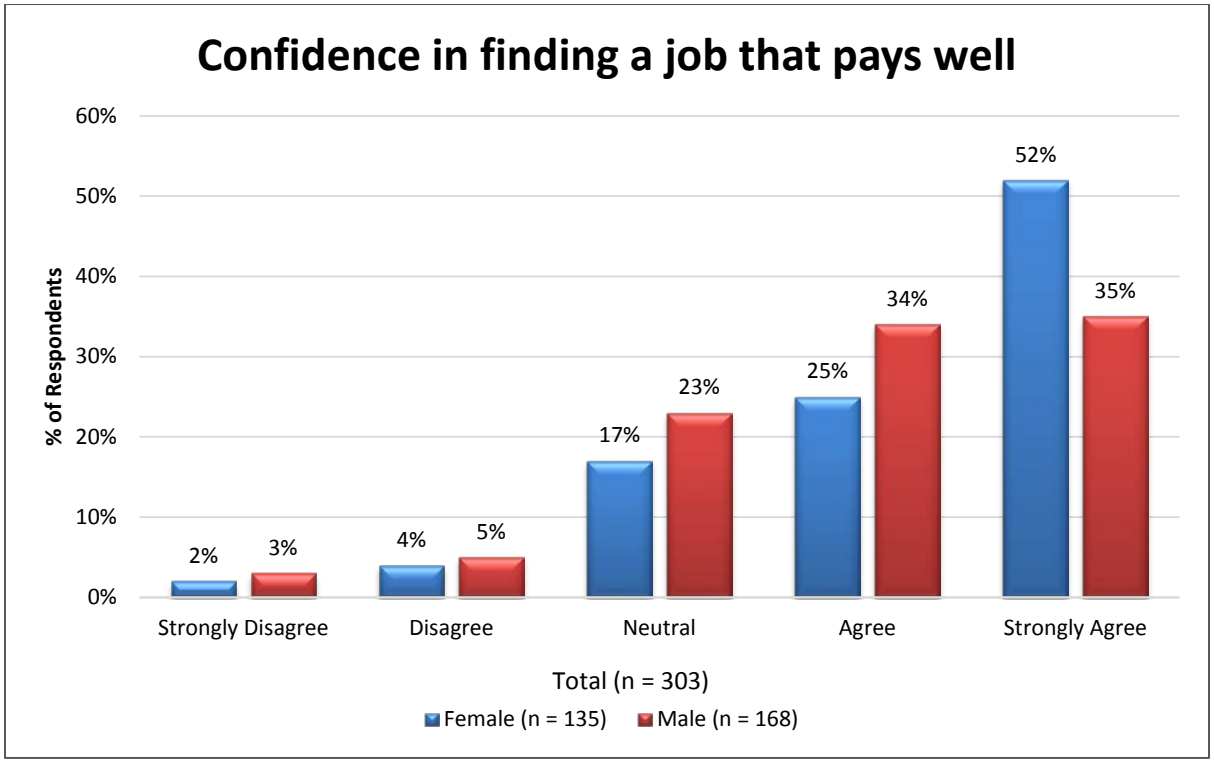

Figure 4.27: Confidence in finding a job that pays well.

Figure 4.27 depicts the responses (n = 303) received from the female responses (n = 135) and male responses (n = 168) for their opinion on 'I feel confident that I could find a job in engineering that pays well'. Two percent (n = 3) of the female respondents indicated **'Strongly Disagree'** and 3 percent (n = 5) of the male respondents indicated **'Strongly Disagree'**. Four percent (n = 6) of the female respondents indicated **'Disagree'** and 5 percent (n = 8) of the male respondents indicated **'Disagree'**. Seventeen percent (n = 23) of the female respondents indicated **'Neutral'** and 23 percent (n = 40) of the male respondents indicated **'Neutral'**. Twenty-five percent (n = 33) of the female respondents indicated **'Agree'** and 34 percent (n = 57) of the male respondents indicated **'Agree'**. Fifty-two percent (n = 70) of the female respondents indicated **'Strongly Agree'** and 35 percent (n = 58) of the male respondents indicated **'Strongly Agree'**.

The findings indicate that the majority of both female and male students strongly agree that they feel confident that they could find a job in engineering that pays well. However, the minority of both female and male students strongly disagree with this statement.

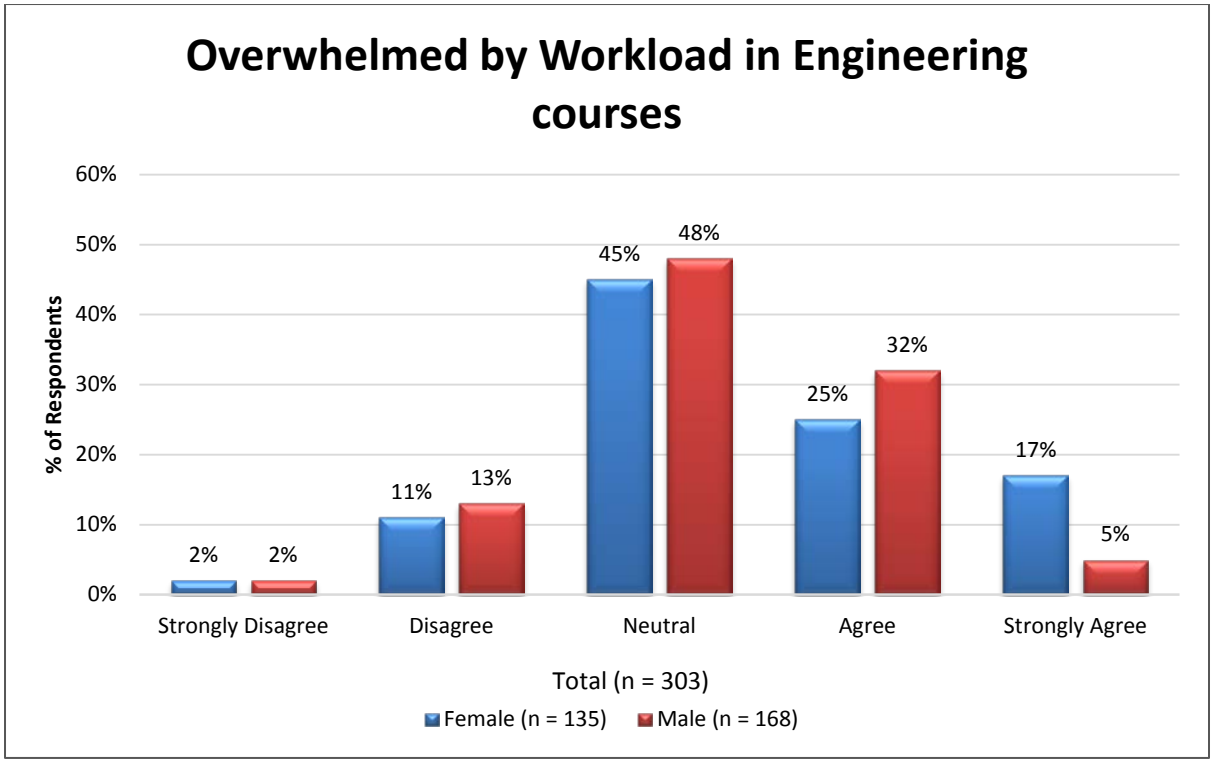

Figure 4.28: Overwhelmed by workload in engineering courses.

Figure 4.28 depicts the responses (n = 303) received from the female responses (n = 135) and male responses (n = 168) for their opinion on 'I am overwhelmed by the workload in my engineering courses'. Two percent (n = 2) of the female respondents indicated **'Strongly Disagree'** and 2 percent (n = 3) of the male respondents indicated **'Strongly Disagree'**. Eleven percent (n = 16) of the female respondents indicated **'Disagree'** and 13 percent (n = 22) of the male respondents indicated **'Disagree'**. Forty-five percent (n = 61) of the female respondents indicated **'Neutral'** and 48 percent (n = 80) of the male respondents indicated **'Neutral'**. Twenty-five percent (n = 33) of the female respondents indicated **'Agree'** and 32 percent (n = 54) of the male respondents indicated **'Agree'**. Seventeen percent (n = 23) of the female respondents indicated **'Strongly Agree'** and 5 percent (n = 9) of the male respondents indicated **'Strongly Agree'**.

The findings indicate that the majority of both female and male students were neutral towards that they feel overwhelmed by the workload in their engineering courses. However, the minority of both female and male students strongly disagree with this statement. Therefore, students' motivation have an impact towards their total study time. However, the workload will have an impact on students' motivation (Kolari et al., 2006).

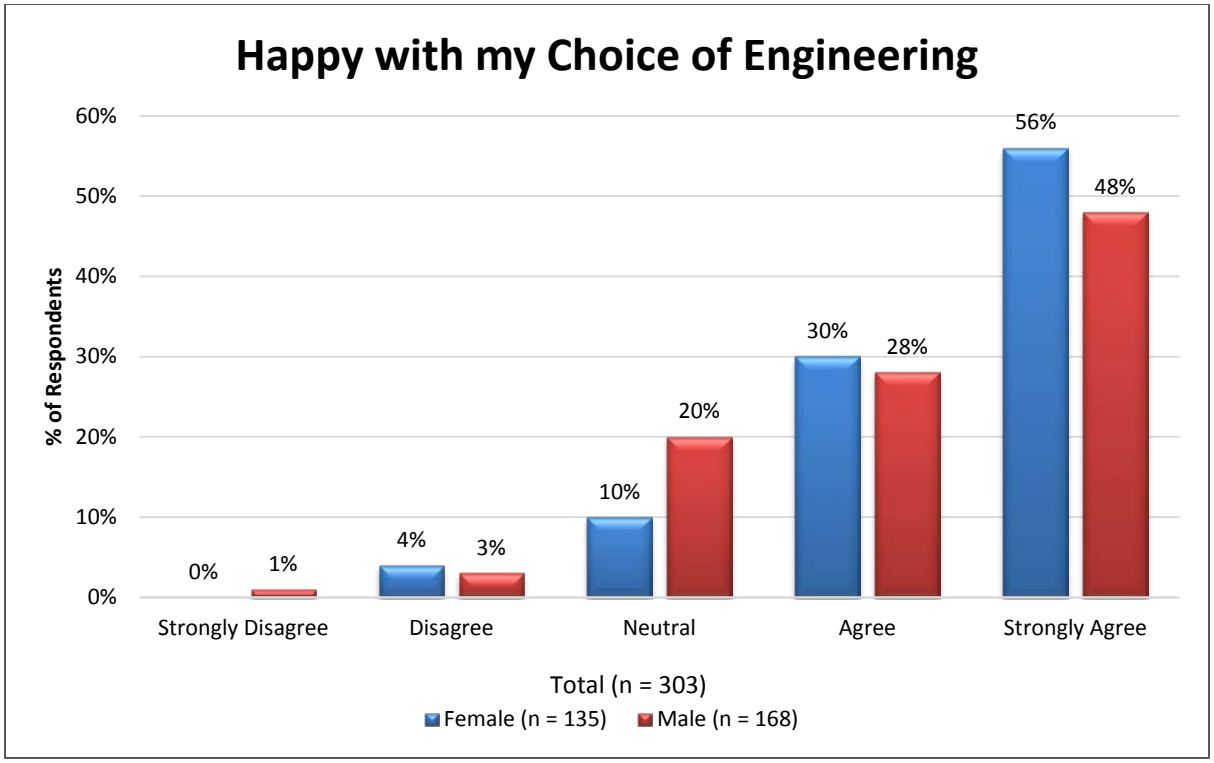

Figure 4.29: Happy with my choice of engineering.

Figure 4.29 depicts the responses (n = 303) received from the female responses (n = 135) and male responses (n = 168) for their opinion on 'I am happy with my choice of engineering'. None of the female respondents indicated **'Strongly Disagree'** and 1 percent (n = 1) of the male respondents indicated **'Strongly Disagree'**. Four percent (n = 5) of the female respondents indicated **'Disagree'** and 3 percent (n = 5) of the male respondents indicated **'Disagree'**. Ten percent (n = 14) of the female respondents indicated **'Neutral'** and 20 percent (n = 33) of the male respondents indicated **'Neutral'**. Thirty percent (n = 41) of the female respondents indicated **'Agree'** and 28 percent (n = 47) of the male respondents indicated **'Agree'**. Fifty-six percent (n = 75) of the female respondents indicated **'Strongly Agree'** and 48 percent (n = 82) of the male respondents indicated **'Strongly Agree'**.

The findings indicate that the majority of both female and male students strongly agree that they feel happy with their choice of engineering. However, the minority of both female and male students strongly disagree with this statement.

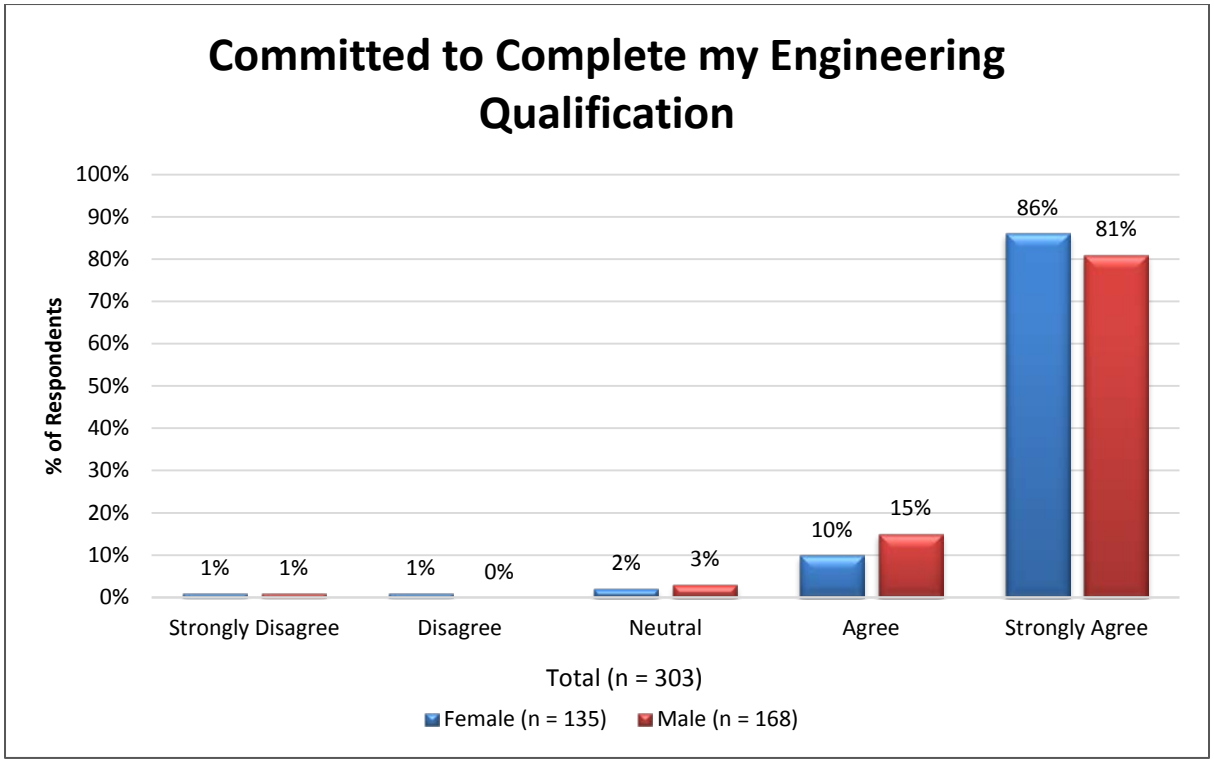

Figure 4.30: Committed to complete my engineering qualification.

Figure 4.30 depicts the responses (n = 303) received from the female responses (n = 135) and male responses (n = 168) for their opinion on 'I am committed to complete my engineering qualification'. One percent (n = 1) of the female respondents indicated **'Strongly Disagree'** and 1 percent (n = 1) of the male respondents indicated **'Strongly Disagree'**. One percent (n = 1) of the female respondents indicated **'Disagree'** and none of the male respondents indicated **'Disagree'**. Two percent (n = 3) of the female respondents indicated **'Neutral'** and 3 percent (n = 5) of the male respondents indicated **'Neutral'**. Ten percent (n = 13) of the female respondents indicated **'Agree'** and 15 percent (n = 26) of the male respondents indicated **'Agree'**. Eighty-six percent (n = 117) of the female respondents indicated **'Strongly Agree'** and 81 percent (n = 136) of the male respondents indicated **'Strongly Agree'**.

The findings indicate that the majority of both female and male students strongly agree that they are committed to completing their engineering qualification. However, the minority of both female and male students disagree with this statement. Therefore, this is aligned with the literature chapter that female students are more likely to complete an engineering qualification compared to male students and they are less likely to change their qualification. (Schreuders et al., 2009). However, there are some reasons why students do not complete their studies, namely financial reasons, wrong career path, switching from one institution to

the next, lack of academic preparedness and not getting enough support from their universities, to name a few (Mtshali, 2013).

Variable	T-tests; Grouping: Gender								
	Mean (1)	Mean (2)	t-value	df	p	Valid N (1)	Valid N (2)	Std Dev. (1)	Std Dev. (2)
Experience	4.19	4.09	1.8614	301	0.06366	135	168	0.47406	0.45815

Table 4.4: T-tests on Gender regarding experience during their studies

Table 4.4 indicates a t-test conducted on gender regarding experience during their studies. $p > 0.05$ which indicates that no significant difference between gender exists with regards to experience during their studies. The mean for both female and male students is four, indicating that the average for both genders indicated 'Agree' on the above variables. The Cronbach Alpha for this construct was established as 0.64 indicating minimally acceptable reliability.

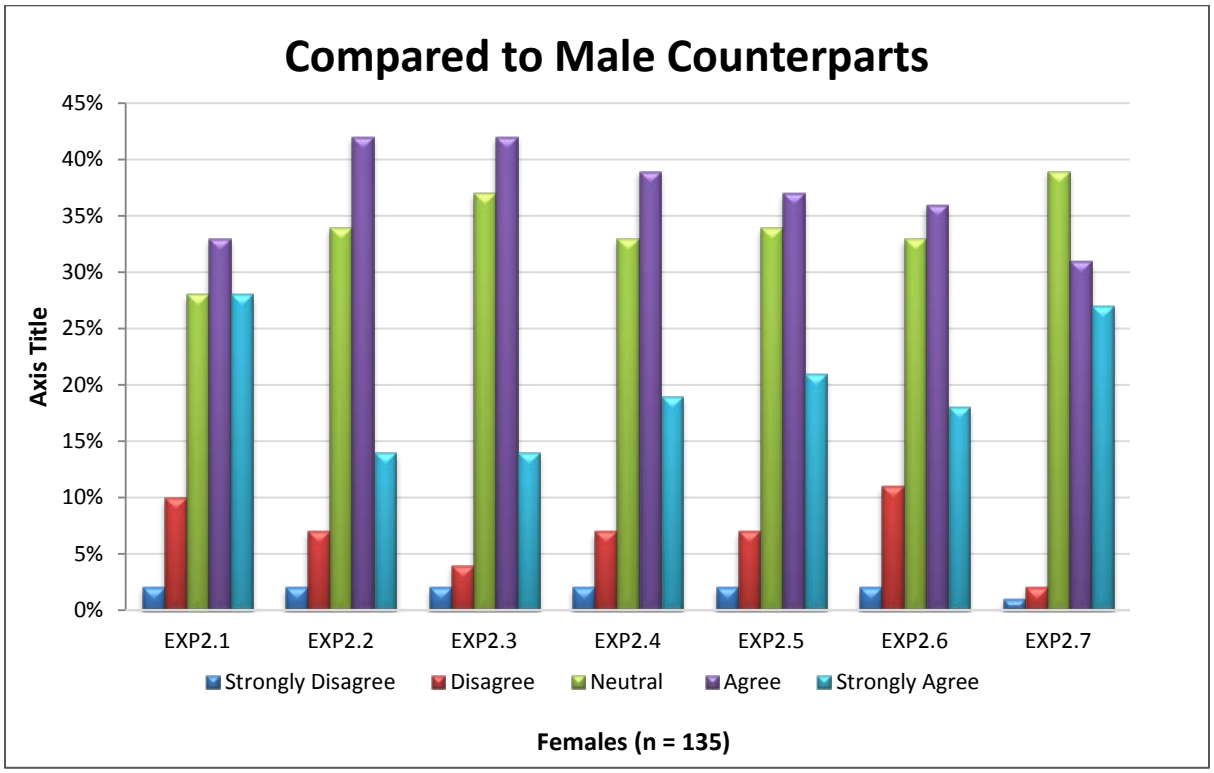

Figure 4.31: Compared to male counterparts

Figure 4.31 depicts the responses (n = 135) received from the female students only regarding their experiences during their studies compared to the male counterparts. This will be discussed in more detail in the following sub-sections.

4.3.2.2.1 EXP2.1: I spend more time and effort on my classwork

Two percent (n = 3) of the female respondents indicated **'Strongly Disagree'**. Ten percent (n = 13) of the female respondents indicated **'Disagree'**. Twenty-eight percent (n = 37) of the female respondents indicated **'Neutral'**. Thirty-three percent (n = 45) of the female respondents indicated **'Agree'**. Twenty-eight percent (n = 37) of the female respondents indicated **'Strongly Agree'**. The findings indicate that the majority of respondents agreed that they spend more time and effort on their classwork compared to their male counterparts. However, the minority of the respondents strongly disagree with this statement.

4.3.2.2.2 EXP2.2: I understand engineering concepts better

Two percent (n = 3) of the female respondents indicated **'Strongly Disagree'**. Seven percent (n = 10) of the female respondents indicated **'Disagree'**. Thirty-four percent (n = 46) of the female respondents indicated **'Neutral'**. Forty-two percent (n = 57) of the female respondents indicated **'Agree'**. Fourteen percent (n = 19) of the female respondents indicated **'Strongly Agree'**. The findings indicate that the majority of respondents agreed that they understand engineering concepts better compared to their male counterparts. However, the minority of the respondents strongly disagree with this statement.

4.3.2.2.3 EXP2.3: I am better at solving engineering problems

Two percent (n = 3) of the female respondents indicated **'Strongly Disagree'**. Four percent (n = 6) of the female respondents indicated **'Disagree'**. Thirty-seven percent (n = 50) of the female respondents indicated **'Neutral'**. Forty-two percent (n = 57) of the female respondents indicated **'Agree'**. Fourteen percent (n = 19) of the female respondents indicated **'Strongly Agree'**. The findings indicate that the majority of respondents agreed that they solve engineering problems better, compared to their male counterparts. However, the minority of the respondents strongly disagree with this statement.

4.3.2.2.4 EXP2.4: I am more committed to engineering

Two percent (n = 3) of the female respondents indicated **'Strongly Disagree'**. Seven percent (n = 10) of the female respondents indicated **'Disagree'**. Thirty-three percent (n = 44) of the female respondents indicated **'Neutral'**. Thirty-nine percent (n = 53) of the female respondents indicated **'Agree'**. Nineteen percent (n = 25) of the female respondents indicated **'Strongly Agree'**. The findings indicate that the majority of respondents agreed that they are more committed to engineering, compared to their male counterparts. However, the minority of the respondents strongly disagree with this statement.

4.3.2.2.5 EXP2.5: I work better with other people

Two percent (n = 2) of the female respondents indicated **'Strongly Disagree'**. Seven percent (n = 9) of the female respondents indicated **'Disagree'**. Thirty-four percent (n = 46) of the female respondents indicated **'Neutral'**. Thirty-seven percent (n = 50) of the female respondents indicated **'Agree'**. Twenty-one percent (n = 28) of the female respondents indicated **'Strongly Agree'**. The findings indicate that the majority of respondents agreed that they work better with other people, compared to their male counterparts. However, the minority of the respondents strongly disagree with this statement.

4.3.2.2.6 EXP2.6: I have more confidence in my engineering abilities

Two percent (n = 2) of the female respondents indicated **'Strongly Disagree'**. Eleven percent (n = 15) of the female respondents indicated **'Disagree'**. Thirty-three percent (n = 45) of the female respondents indicated **'Neutral'**. Thirty-six percent (n = 49) of the female respondents indicated **'Agree'**. Eighteen percent (n = 24) of the female respondents indicated **'Strongly Agree'**. The findings indicate that the majority of respondents agreed that they have more confidence in their engineering abilities, compared to their male counterparts. However, the minority of the respondents strongly disagree with this statement.

4.3.2.2.7 EXP2.7: I have developed better analytical skills

One percent (n = 1) of the female respondents indicated **'Strongly Disagree'**. Two percent (n = 3) of the female respondents indicated **'Disagree'**. Thirty-nine percent (n = 52) of the female respondents indicated **'Neutral'**. Thirty-one percent (n = 42) of the female respondents indicated **'Agree'**. Twenty-seven percent (n = 37) of the female respondents indicated **'Strongly Agree'**. The findings indicate that the majority of respondents feel neutral on the statement that they have developed better analytical skills, compared to their male counterparts. However, the minority of the respondents strongly disagree with this statement.

The following sub-section will summarise the research findings of Section 3.

4.3.2.5. Summary of Research Findings in Section 3

Section 3 – Experience During your Engineering Studies was used to collect data regarding the importance of the students' experience during their engineering studies. The findings indicate the majority of both female and male students did not take a leave of absence. The

majority of both female and male students indicated that their mathematics, science, engineering and overall academic abilities increased since starting the university. Therefore, this result is excellent as female and male students did not participate in a lot of mathematics and science activities during high school years.

During their studies, the majority of both female and male students indicated that they sometimes fail to do their best work and sometimes seek to improve their designs or projects. However, both female and male students indicated that they always complete their assignments on time, complete their part of assignment when working in teams and are dependable. It is also clear in this section that both female and male students have a high level of interest in engineering, they are satisfied with their choice in engineering and they are committed to complete their qualification. Therefore, this indicates that there is no significant difference between the different genders. However, female students do feel that they spend more time on classwork, their understanding of engineering concepts and problem solving are better, work better with other people and they are more committed to engineering than what the male counterparts are. From these findings, it is clear that according to the female students, they are more committed and hardworking compared to the male students in engineering. This could result from being the minority of students in engineering and they need to work harder compared to male students, in order to prove themselves.

The following sub-section will elaborate on the findings for Section 4 – Most Influential People During Studies.

4.3.2.6. Section 4 – Most Influential People During Studies

In this section, data were captured regarding the most influential people during the students' studies, which include the most and least encouragements towards the students' studies.

Figures 4.32 – 4.37 depicts both female and male students' perception on their encouragement received from various individuals. The total number of respondents ('n' values) will differ for these following figures, as the 'Not Applicable' has been removed from the statistics in order to indicate better results, as this will contribute to the validity and reliability of the study. This was recommended by the statistician. The findings will be elaborated below.

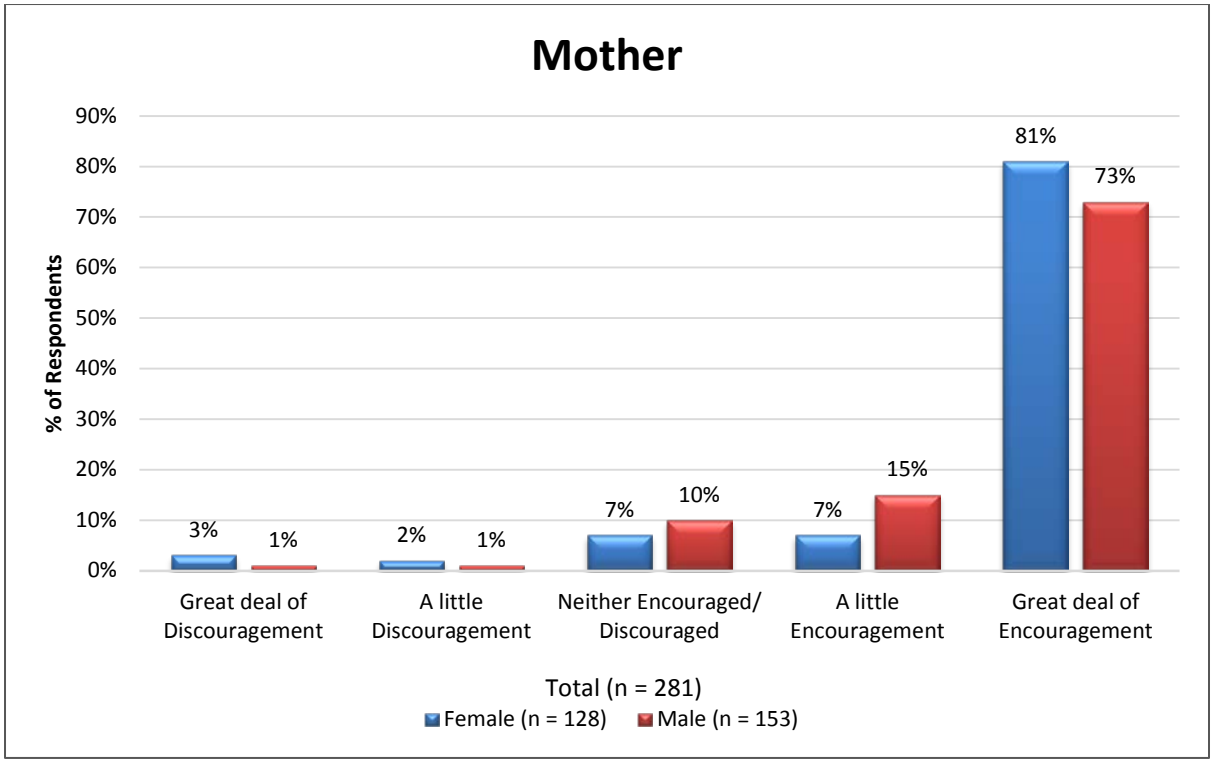

Figure 4.32: Mother.

Figure 4.32 depicts the total responses (n = 281) received, which is represented by female responses (n = 128) and male responses (n = 153) for their opinion on whether they are encouraged by their 'mother'. Three percent (n = 4) of the female respondents indicated **'Great deal of Discouragement'** and 1 percent (n = 1) of the male respondents indicated **'Great deal of Discouragement'**. Two percent (n = 3) of the female respondents indicated **'A little Discouragement'** and 1 percent (n = 2) of the male respondents indicated **'A little Discouragement'**. Seven percent (n = 9) of the female respondents indicated **'Neither Encouraged/ Discouraged'** and 10 percent (n = 15) of the male respondents indicated **'Neither Encouraged/ Discouraged'**. Seven percent (n = 9) of the female respondents indicated **'A little Encouragement'** and 15 percent (n = 23) of the male respondents indicated **'A little Encouragement'**. Eighty-one percent (n = 103) of the female respondents indicated **'Great deal of Encouragement'** and 73 percent (n = 112) of the male respondents indicated **'Great deal of Encouragement'**.

The findings indicate that the majority of both female and male students are greatly encouraged by their mother. However, the minority of both female and male students are discouraged by their mother.

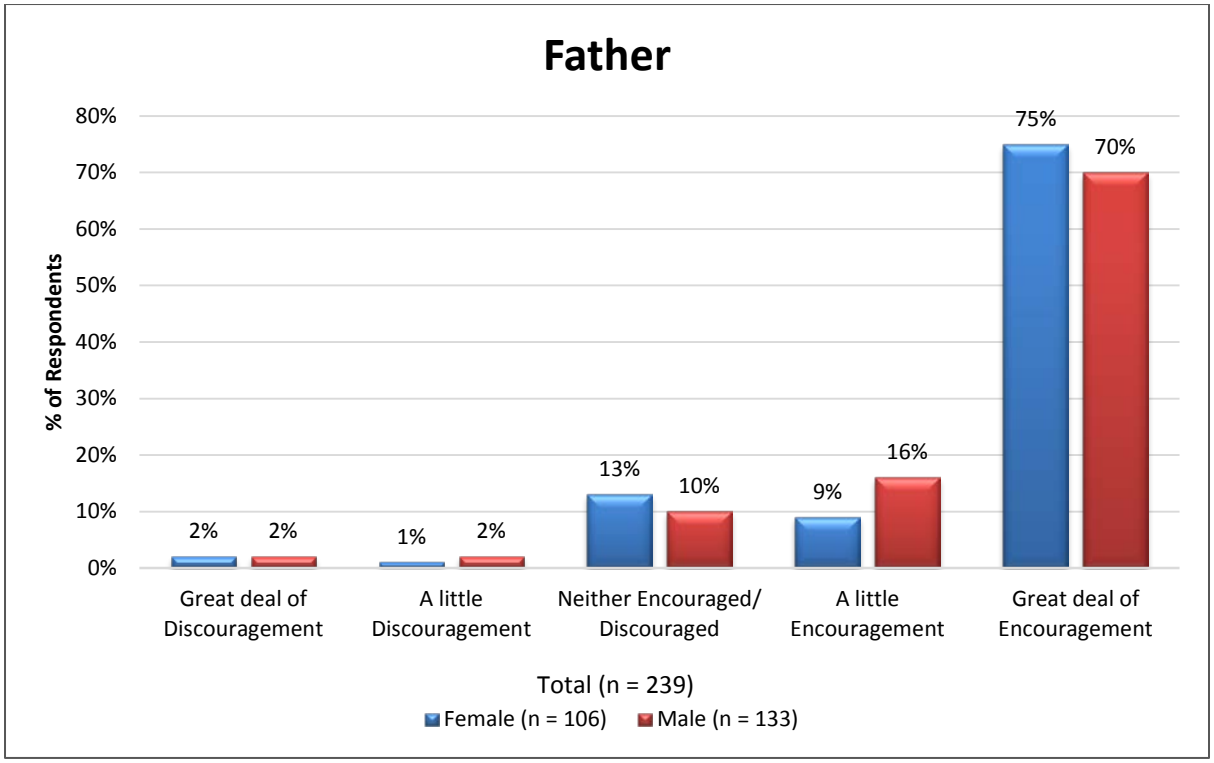

Figure 4.33: Father.

Figure 4.33 depicts the total responses (n = 239) received, which is represented by female responses (n = 106) and male responses (n = 133) for their opinion on whether they are encouraged by their 'Mother'. Two percent (n = 2) of the female respondents indicated **'Great deal of Discouragement'** and 2 percent (n = 2) of the male respondents indicated **'Great deal of Discouragement'**. One percent (n = 1) of the female respondents indicated **'A little Discouragement'** and 2 percent (n = 2) of the male respondents indicated **'A little Discouragement'**. Thirteen percent (n = 14) of the female respondents indicated **'Neither Encouraged/ Discouraged'** and 10 percent (n = 14) of the male respondents indicated **'Neither Encouraged/ Discouraged'**. Nine percent (n = 10) of the female respondents indicated **'A little Encouragement'** and 16 percent (n = 21) of the male respondents indicated **'A little Encouragement'**. Seventy-five percent (n = 79) of the female respondents indicated **'Great deal of Encouragement'** and 70 percent (n = 94) of the male respondents indicated **'Great deal of Encouragement'**.

The findings indicate that the majority of both female and male students are greatly encouraged by their father. However, the minority of both female and male students are discouraged by their father.

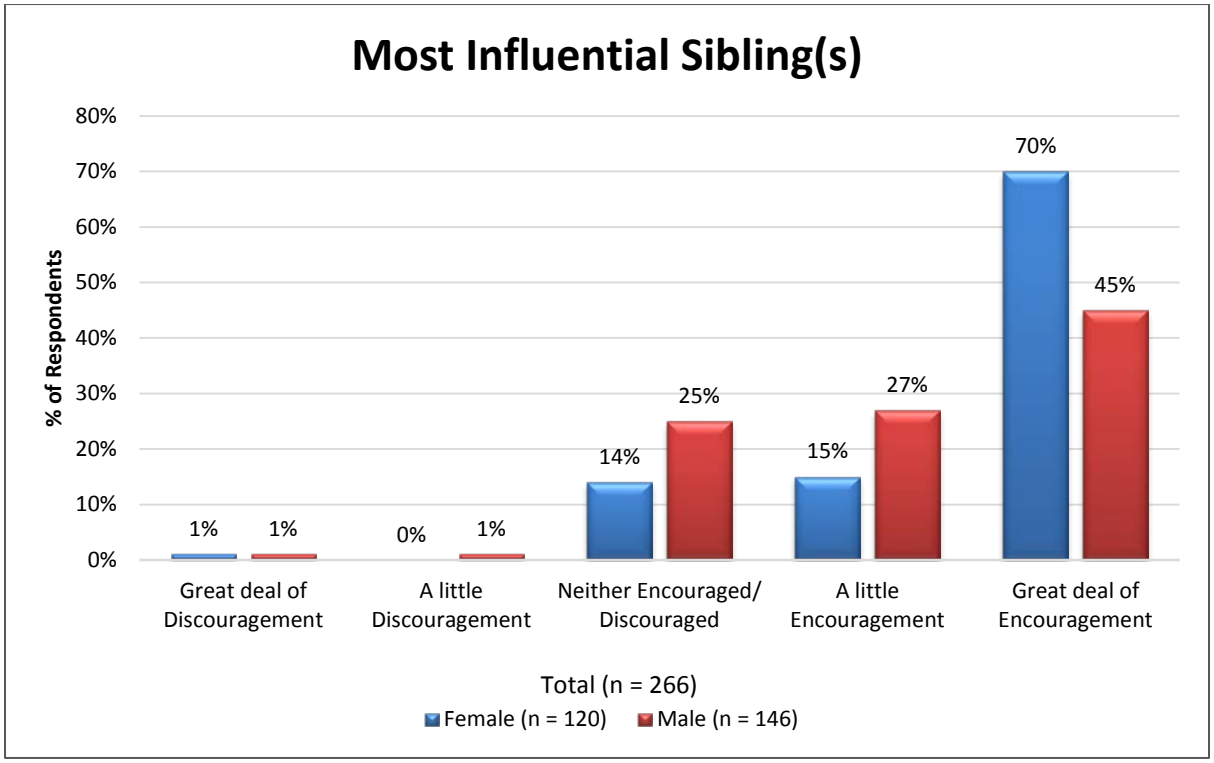

Figure 4.34: Most influential sibling(s).

Figure 4.34 depicts the total responses (n = 266) received, which is represented by female responses (n = 120) and male responses (n = 146) for their opinion on whether they are encouraged by their 'most influential sibling(s)'. One percent (n = 1) of the female respondents indicated **'Great deal of Discouragement'** and 1 percent (n = 2) of the male respondents indicated **'Great deal of Discouragement'**. None of the female respondents indicated **'A little Discouragement'** and 1 percent (n = 2) of the male respondents indicated **'A little Discouragement'**. Fourteen percent (n = 17) of the female respondents indicated **'Neither Encouraged/ Discouraged'** and 25 percent (n = 37) of the male respondents indicated **'Neither Encouraged/ Discouraged'**. Fifteen percent (n = 18) of the female respondents indicated **'A little Encouragement'** and 27 percent (n = 39) of the male respondents indicated **'A little Encouragement'**. Seventy percent (n = 84) of the female respondents indicated **'Great deal of Encouragement'** and 45 percent (n = 66) of the male respondents indicated **'Great deal of Encouragement'**.

The findings indicate that the majority of both female and male students are greatly encouraged by the most influential sibling(s). However, the minority of both female and male students are discouraged by the most influential sibling(s).

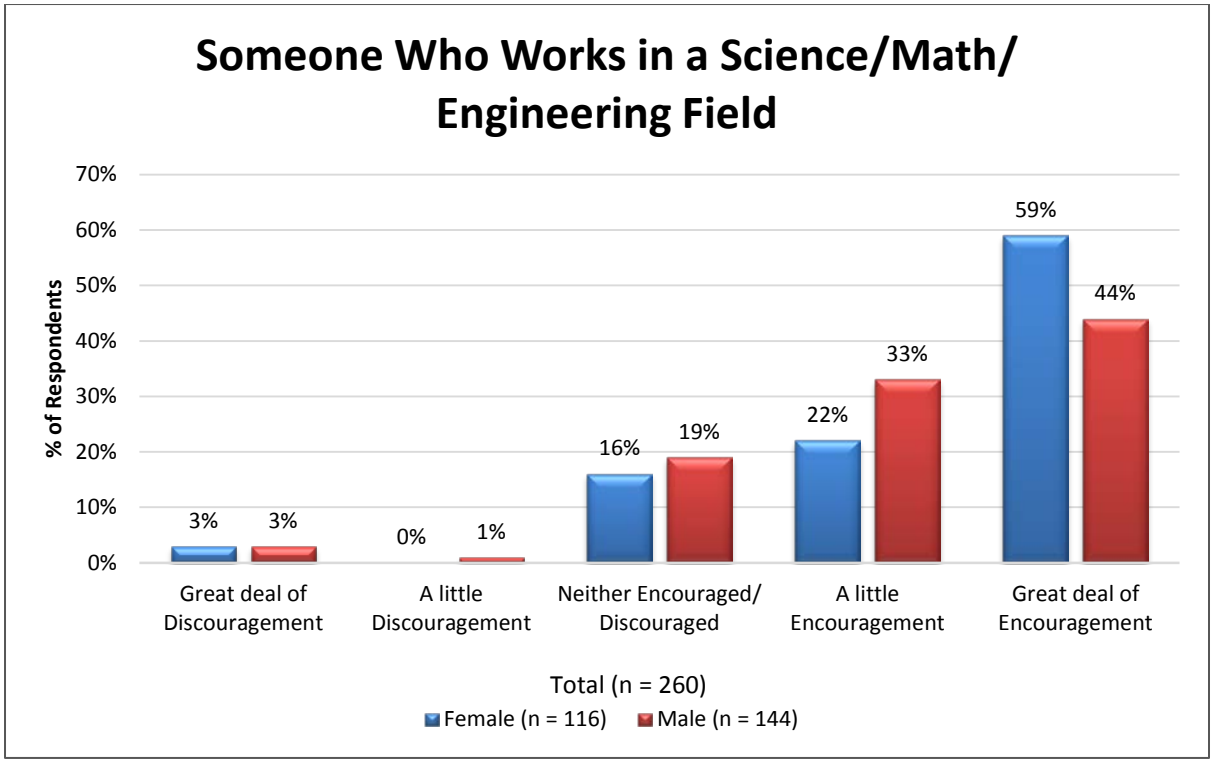

Figure 4.35: Someone who works in a science/math/engineering field.

Figure 4.35 depicts the total responses (n = 260) received, which is represented by female responses (n = 116) and male responses (n = 144) for their opinion on whether they are encouraged by 'someone who works in a science, mathematics or engineering field'. Three percent (n = 3) of the female respondents indicated **'Great deal of Discouragement'** and 3 percent (n = 5) of the male respondents indicated **'Great deal of Discouragement'**. None of the female respondents indicated **'A little Discouragement'** and 1 percent (n = 1) of the male respondents indicated **'A little Discouragement'**. Sixteen percent (n = 18) of the female respondents indicated **'Neither Encouraged/ Discouraged'** and 19 percent (n = 27) of the male respondents indicated **'Neither Encouraged/ Discouraged'**. Twenty-two percent (n = 26) of the female respondents indicated **'A little Encouragement'** and 33 percent (n = 47) of the male respondents indicated **'A little Encouragement'**. Fifty-nine percent (n = 69) of the female respondents indicated **'Great deal of Encouragement'** and 44 percent (n = 64) of the male respondents indicated **'Great deal of Encouragement'**.

The findings indicate that the majority of both female and male students are greatly encouraged by someone who works in a science, mathematics or engineering field. However, the minority of both female and male students are a little discouraged by someone who works in a science, mathematics or engineering field.

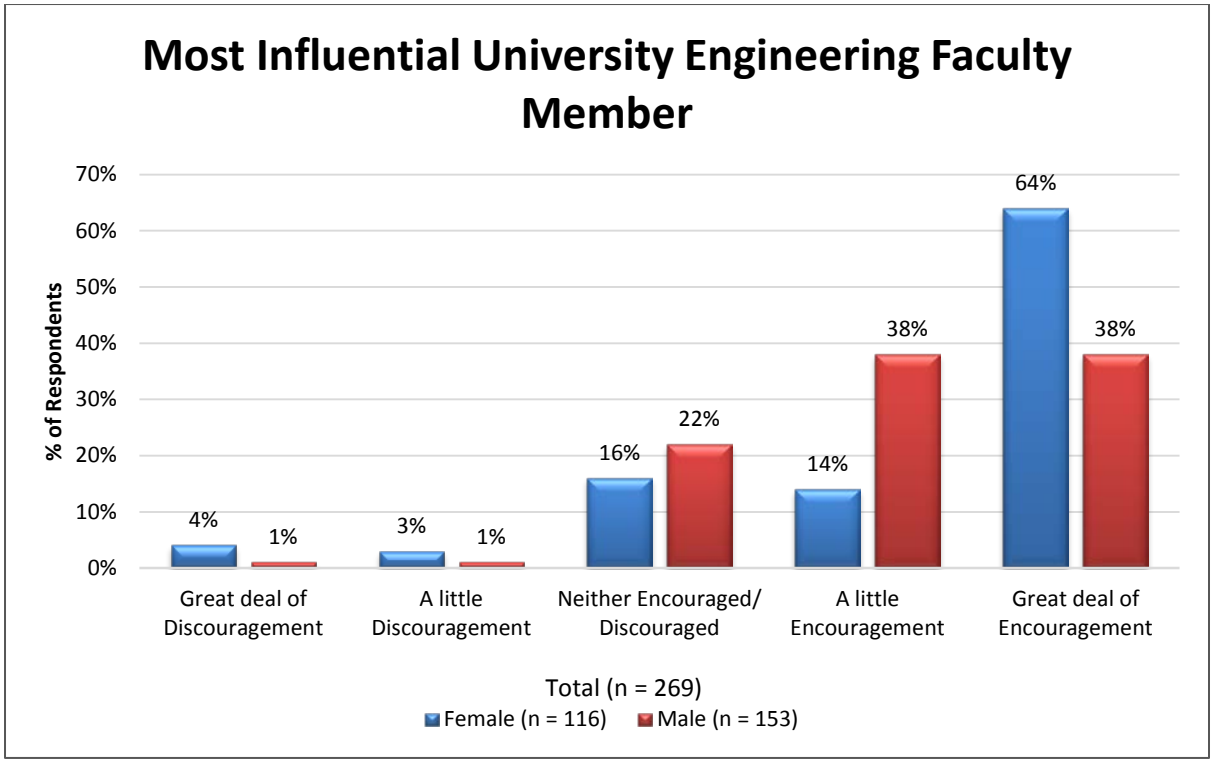

Figure 4.36: Most influential university Engineering Faculty member.

Figure 4.36 depicts the total responses (n = 269) received, which is represented by female responses (n = 116) and male responses (n = 153) for their opinion on whether they are encouraged by the 'most influential university engineering faculty member'. Four percent (n = 4) of the female respondents indicated **'Great deal of Discouragement'** and 1 percent (n = 1) of the male respondents indicated **'Great deal of Discouragement'**. Three percent (n = 3) of the female respondents indicated **'A little Discouragement'** and 2 percent (n = 1) of the male respondents indicated **'A little Discouragement'**. Sixteen percent (n = 19) of the female respondents indicated **'Neither Encouraged/ Discouraged'** and 22 percent (n = 34) of the male respondents indicated **'Neither Encouraged/ Discouraged'**. Fourteen percent (n = 16) of the female respondents indicated **'A little Encouragement'** and 38 percent (n = 58) of the male respondents indicated **'A little Encouragement'**. Sixty-four percent (n = 74) of the female respondents indicated **'Great deal of Encouragement'** and 38 percent (n = 58) of the male respondents indicated **'Great deal of Encouragement'**.

The findings indicate that the majority of both female and male students are greatly encouraged by the most influential university engineering faculty member. However, the minority of both female and male students are discouraged by the most influential university engineering faculty member.

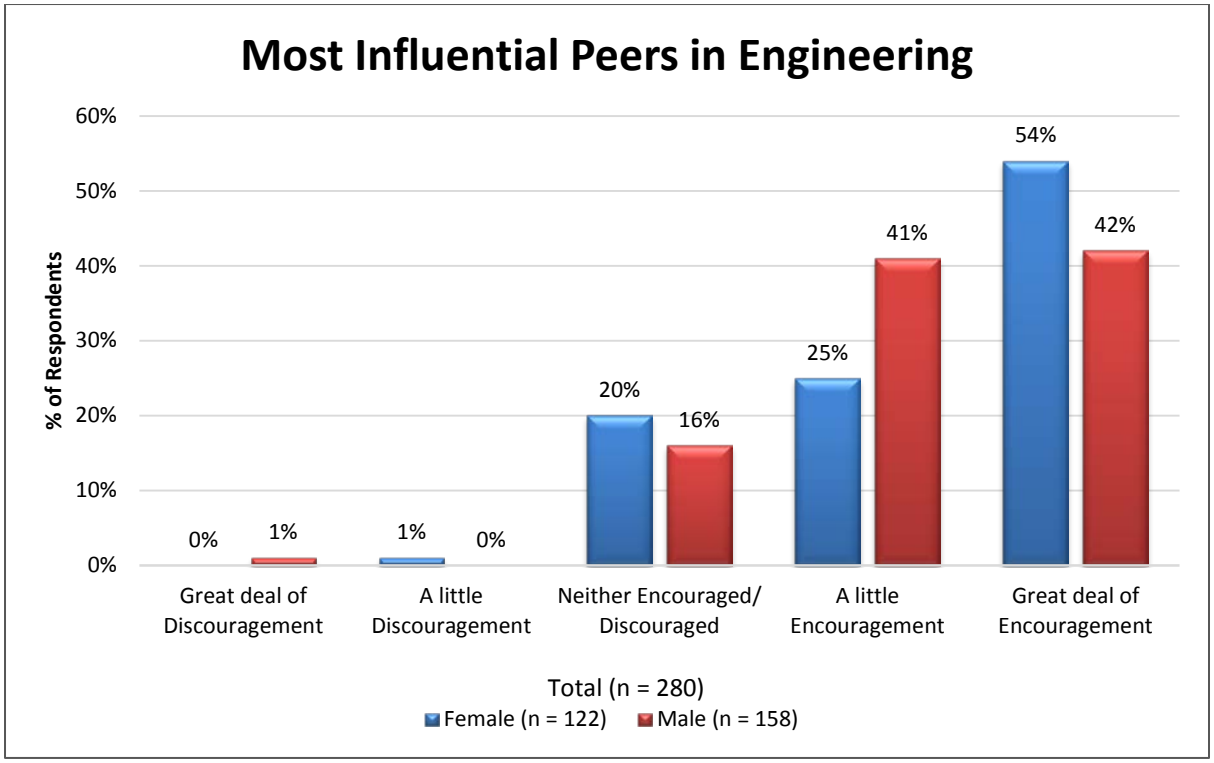

Figure 4.37: Most influential peers in engineering.

Figure 4.37 depicts the total responses (n = 280) received, which is represented by female responses (n = 122) and male responses (n = 158) for their opinion on whether they are encouraged by their 'Mother'. None of the female respondents indicated **'Great deal of Discouragement'** and 1 percent (n = 2) of the male respondents indicated **'Great deal of Discouragement'**. One percent (n = 1) of the female respondents indicated **'A little Discouragement'** and none of the male respondents indicated **'A little Discouragement'**. Twenty percent (n = 24) of the female respondents indicated **'Neither Encouraged/ Discouraged'** and 16 percent (n = 25) of the male respondents indicated **'Neither Encouraged/ Discouraged'**. Twenty-five percent (n = 30) of the female respondents indicated **'A little Encouragement'** and 41 percent (n = 65) of the male respondents indicated **'A little Encouragement'**. Fifty-four percent (n = 67) of the female respondents indicated **'Great deal of Encouragement'** and 42 percent (n = 66) of the male respondents indicated **'Great deal of Encouragement'**.

The findings indicate that the majority of both female and male students are greatly encouraged by the most influential peers in engineering. However, the minority of both female and male students are discouraged by the most influential peers in engineering.

Figures 4.38 – 4.49 depicts both female and male students' perception on their encouragement received from varies statements. The total number of respondents ('n' values) will differ for these following figures, as the 'Not Applicable' has been removed from the statistics in order to indicate better results, as this will contribute to the validity and reliability of the study. This was recommended by the statistician. The findings will be elaborated below.

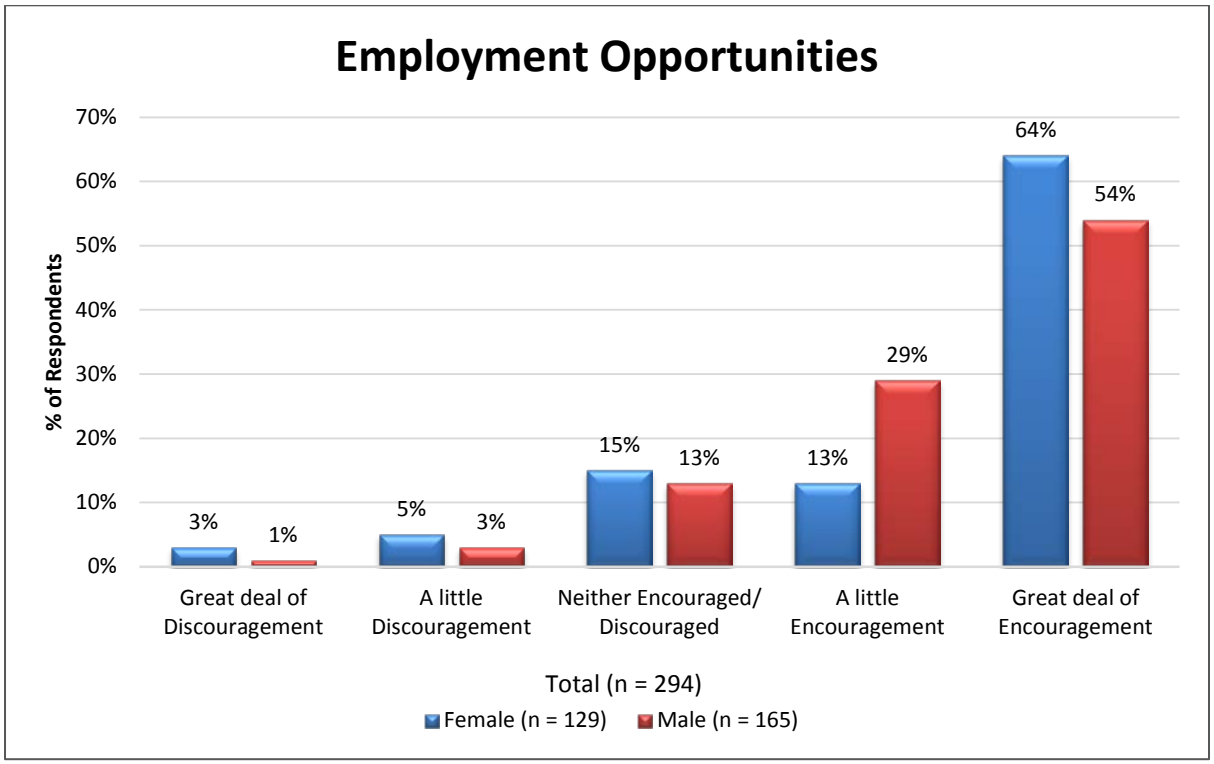

Figure 4.38: Employment opportunities.

Figure 4.38 depicts the total responses (n = 294) received, which is represented by female responses (n = 129) and male responses (n = 165) for their opinion on whether they are encouraged by the 'employment opportunities'. Four percent (n = 3) of the female respondents indicated **'Great deal of Discouragement'** and 1 percent (n = 2) of the male respondents indicated **'Great deal of Discouragement'**. Five percent (n = 6) of the female respondents indicated **'A little Discouragement'** and 3 percent (n = 5) of the male respondents indicated **'A little Discouragement'**. Fifteen percent (n = 19) of the female respondents indicated **'Neither Encouraged/ Discouraged'** and 13 percent (n = 22) of the male respondents indicated **'Neither Encouraged/ Discouraged'**. Thirteen percent (n = 17) of the female respondents indicated **'A little Encouragement'** and 29 percent (n = 47) of the male respondents indicated **'A little Encouragement'**. Sixty-four percent (n = 83) of

the female respondents indicated **'Great deal of Encouragement'** and 54 percent (n = 89) of the male respondents indicated **'Great deal of Encouragement'**.

The findings indicate that the majority of both female and male students are greatly encouraged by employment opportunities. However, the minority of both female and male students are greatly discouraged by employment opportunities. Furthermore, students should be equipped to face a future that is constantly changing. Therefore, students need adequate training that makes them suitable for employability (Baillie & Fitzgerald, 2000; Magnell et al., 2016).

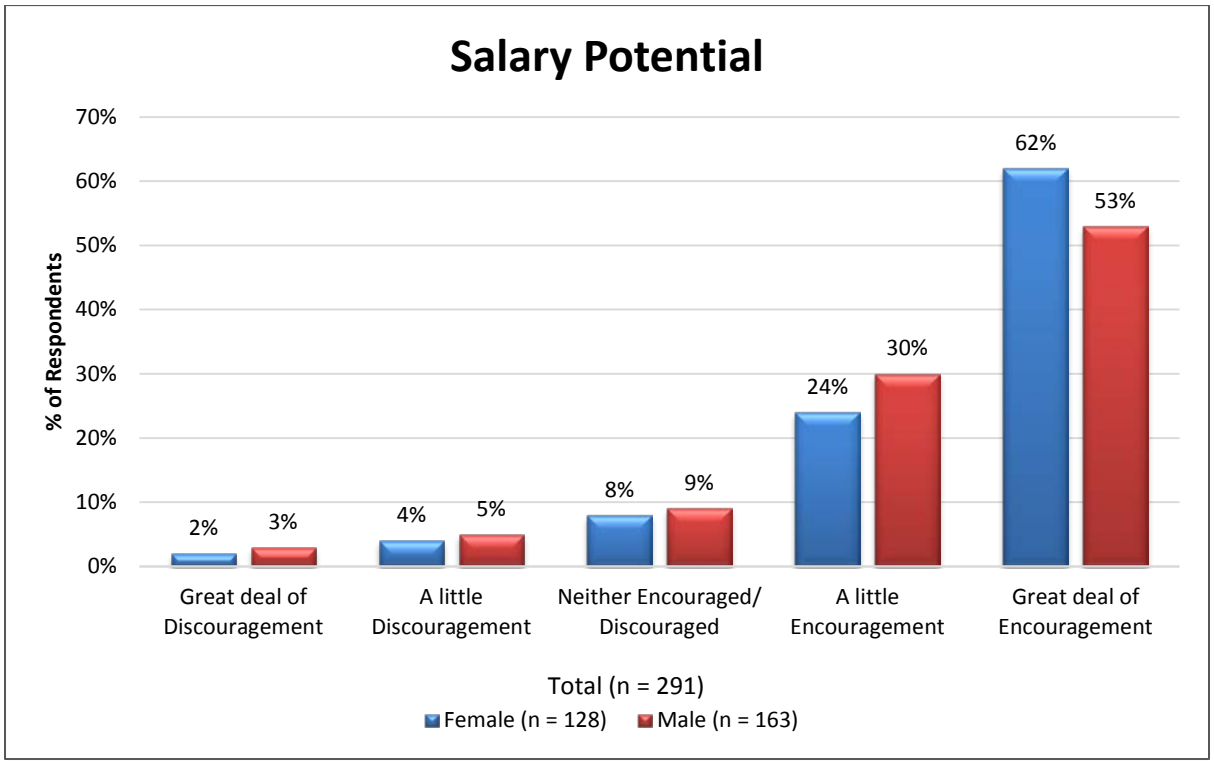

Figure 4.39: Salary potential.

Figure 4.39 depicts the total responses (n = 291) received, which is represented by female responses (n = 128) and male responses (n = 163) for their opinion on whether they are encouraged by the 'salary potential'. Two percent (n = 3) of the female respondents indicated **'Great deal of Discouragement'** and 3 percent (n = 4) of the male respondents indicated **'Great deal of Discouragement'**. Four percent (n = 5) of the female respondents indicated **'A little Discouragement'** and 5 percent (n = 8) of the male respondents indicated **'A little Discouragement'**. Eight percent (n = 10) of the female respondents indicated **'Neither Encouraged/ Discouraged'** and 9 percent (n = 14) of the male respondents indicated **'Neither Encouraged/ Discouraged'**. Twenty-four percent (n = 31) of the female

respondents indicated **'A little Encouragement'** and 30 percent (n = 50) of the male respondents indicated **'A little Encouragement'**. Sixty-two percent (n = 79) of the female respondents indicated **'Great deal of Encouragement'** and 53 percent (n = 87) of the male respondents indicated **'Great deal of Encouragement'**.

The findings indicate that the majority of both female and male students are greatly encouraged by salary potential. However, the minority of both female and male students are greatly discouraged by salary potential.

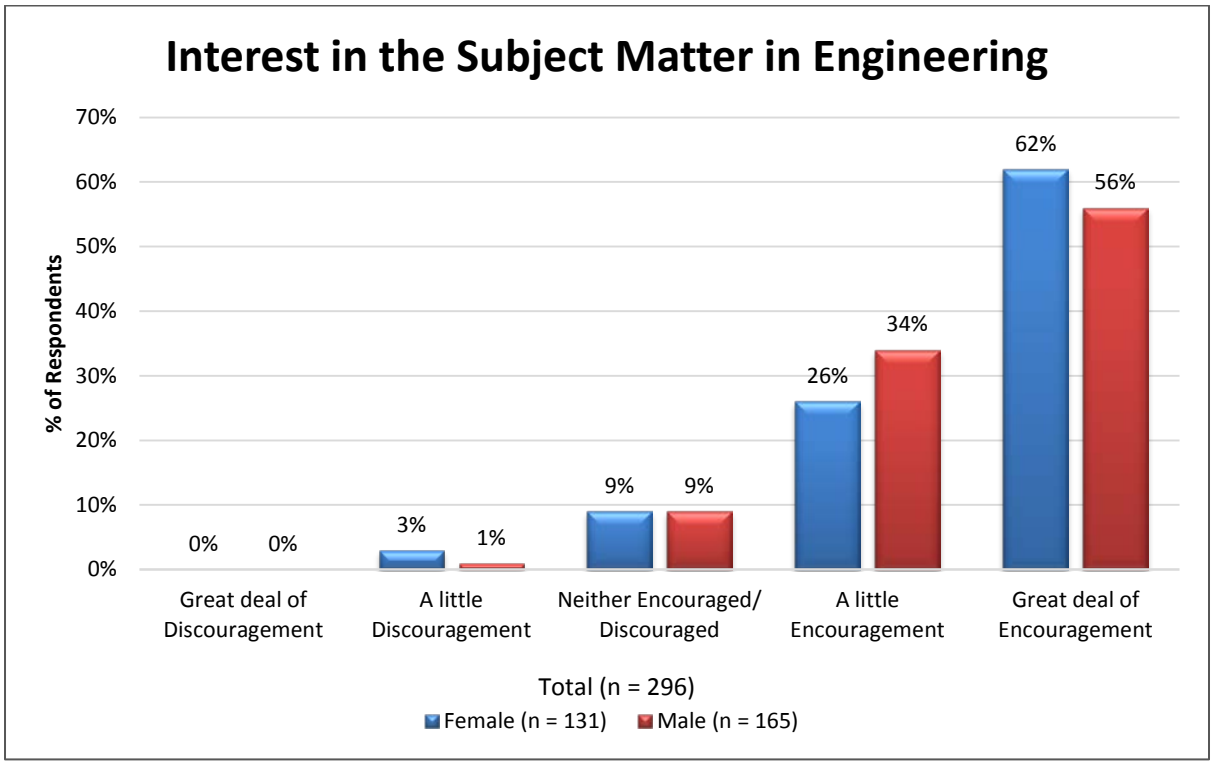

Figure 4.40: Interest in the subject matter in engineering.

Figure 4.40 depicts the total responses (n = 296) received, which is represented by female responses (n = 131) and male responses (n = 165) for their opinion on whether they are encouraged by the 'interest in the subject matter in engineering'. Both female and male respondents indicated none that have **'Great deal of Discouragement'**. Three percent (n = 4) of the female respondents indicated **'A little Discouragement'** and 1 percent (n = 1) of the male respondents indicated **'A little Discouragement'**. Nine percent (n = 12) of the female respondents indicated **'Neither Encouraged/ Discouraged'** and 9 percent (n = 15) of the male respondents indicated **'Neither Encouraged/ Discouraged'**. Twenty-six percent (n = 34) of the female respondents indicated **'A little Encouragement'** and 34 percent (n = 56) of the male respondents indicated **'A little Encouragement'**. Sixty-two

percent (n = 81) of the female respondents indicated **'Great deal of Encouragement'** and 56 percent (n = 93) of the male respondents indicated **'Great deal of Encouragement'**.

The findings indicate that the majority of both female and male students are greatly encouraged by interest in the subject matter in engineering. However, the minority of both female and male students are greatly discouraged by their interest in the subject matter in engineering.

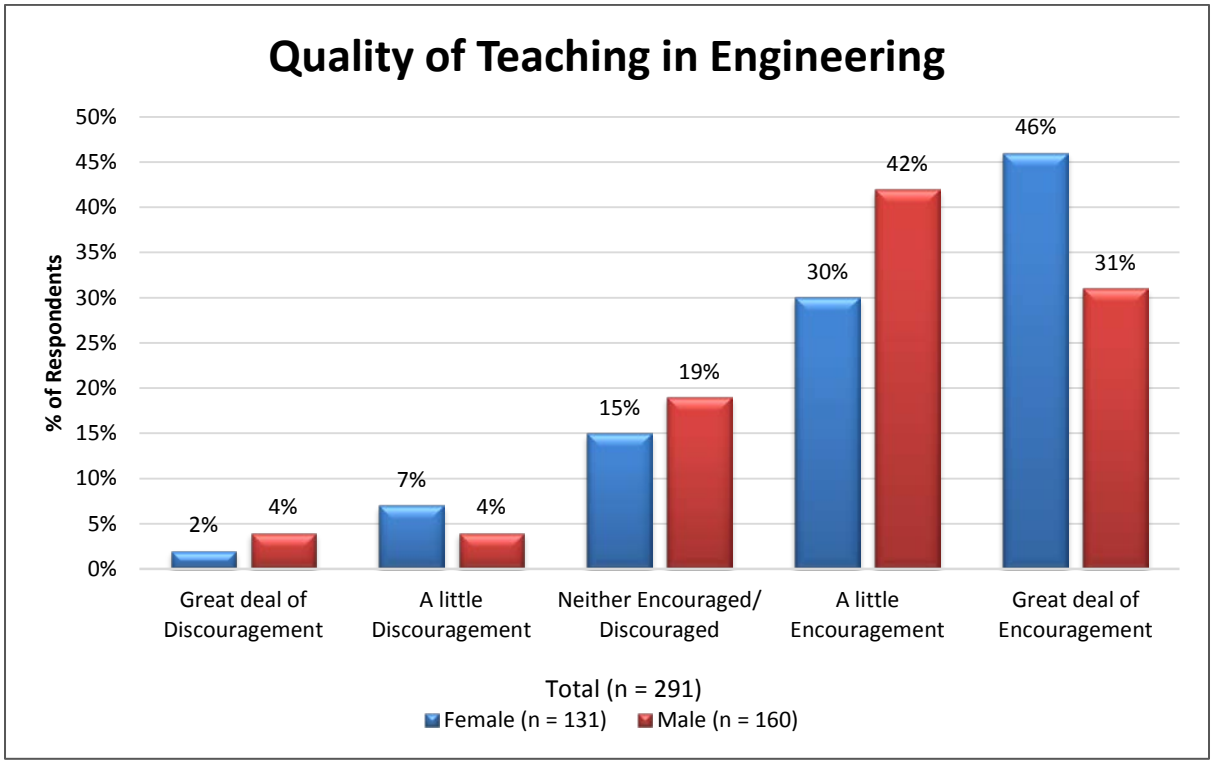

Figure 4.41: Quality of teaching in engineering.

Figure 4.41 depicts the total responses (n = 291) received, which is represented by female responses (n = 131) and male responses (n = 160) for their opinion on whether they are encouraged by the 'quality of teaching in engineering'. Two percent (n = 3) of the female respondents indicated **'Great deal of Discouragement'** and 4 percent (n = 6) of the male respondents indicated **'Great deal of Discouragement'**. Seven percent (n = 9) of the female respondents indicated **'A little Discouragement'** and 4 percent (n = 6) of the male respondents indicated **'A little Discouragement'**. Fifteen percent (n = 19) of the female respondents indicated **'Neither Encouraged/ Discouraged'** and 19 percent (n = 30) of the male respondents indicated **'Neither Encouraged/ Discouraged'**. Thirty percent (n = 39) of the female respondents indicated **'A little Encouragement'** and 67 percent (n = 42) of the male respondents indicated **'A little Encouragement'**. Forty-six percent (n = 61) of the

female respondents indicated **'Great deal of Encouragement'** and 31 percent (n = 50) of the male respondents indicated **'Great deal of Encouragement'**.

The findings indicate that the majority of female students are greatly encouraged by the quality of teaching in engineering and the majority of male students are a little encouraged by the quality of teaching in engineering. However, the minority of both female and male students are greatly discouraged by the quality of teaching in engineering.

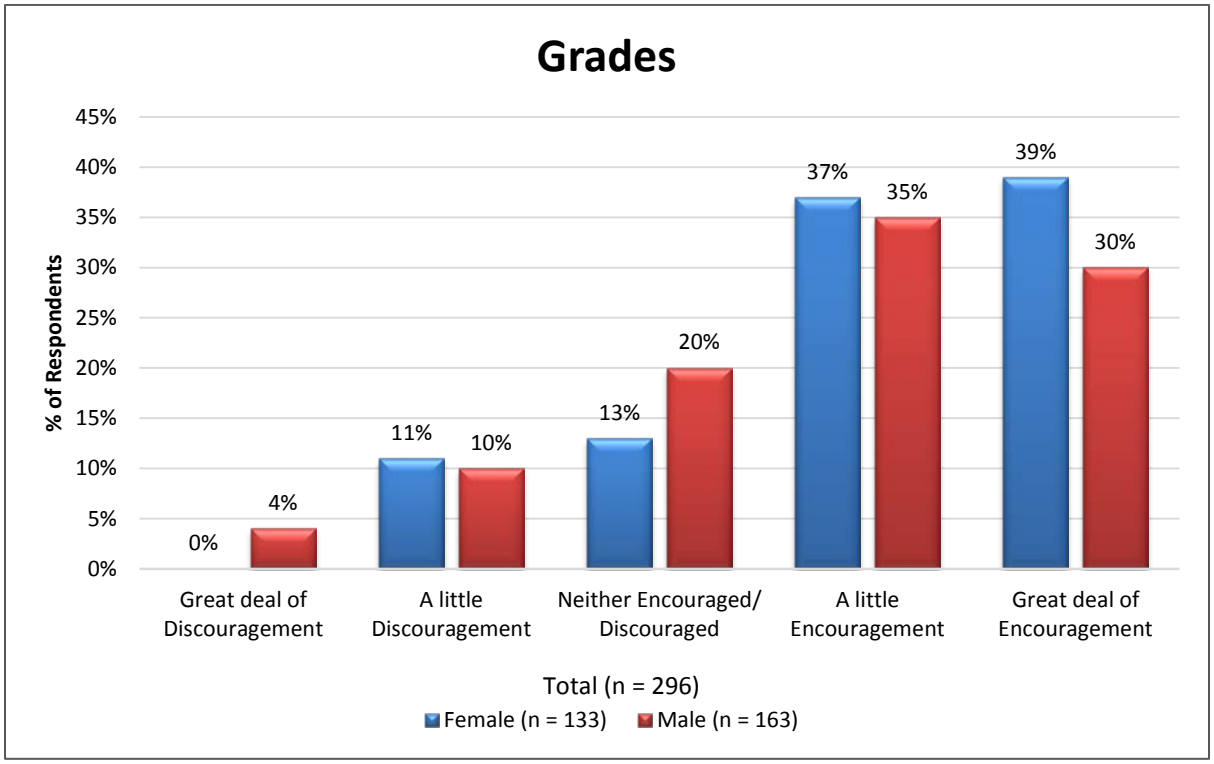

Figure 4.42: Grades.

Figure 4.42 depicts the total responses (n = 296) received, which is represented by female responses (n = 133) and male responses (n = 163) for their opinion on whether they are encouraged by their 'grades'. None of the female respondents indicated **'Great deal of Discouragement'** and 4 percent (n = 7) of the male respondents indicated **'Great deal of Discouragement'**. Eleven percent (n = 14) of the female respondents indicated **'A little Discouragement'** and 10 percent (n = 16) of the male respondents indicated **'A little Discouragement'**. Thirteen percent (n = 17) of the female respondents indicated **'Neither Encouraged/ Discouraged'** and 20 percent (n = 33) of the male respondents indicated **'Neither Encouraged/ Discouraged'**. Thirty-seven percent (n = 50) of the female respondents indicated **'A little Encouragement'** and 35 percent (n = 57) of the male respondents indicated **'A little Encouragement'**. Thirty-nine percent (n = 52) of the female

respondents indicated **'Great deal of Encouragement'** and 30 percent (n = 50) of the male respondents indicated **'Great deal of Encouragement'**.

The findings indicate that the majority of female students are greatly encouraged by their grades and the majority of male students are a little encouraged by their grades. However, the minority of both female and male students are greatly discouraged by their grades.

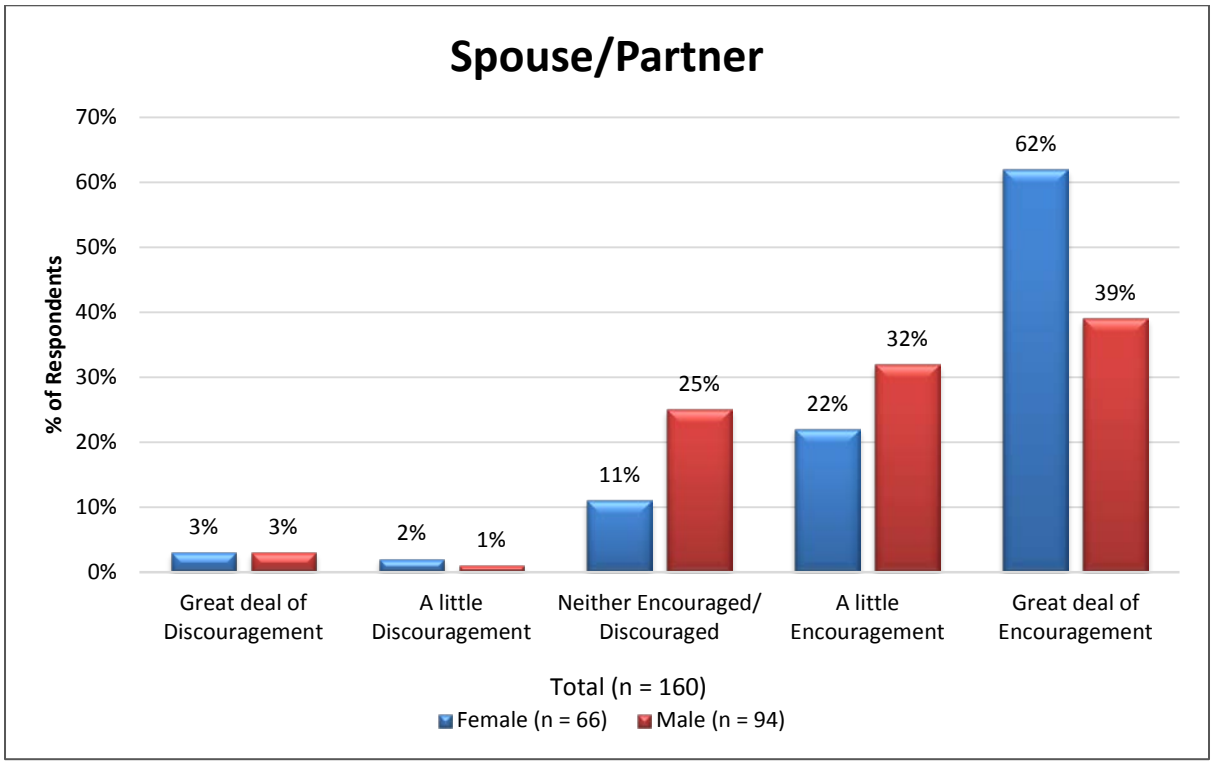

Figure 4.43: Spouse/partner.

Figure 4.43 depicts the total responses (n = 160) received, which is represented by female responses (n = 66) and male responses (n = 94) for their opinion on whether they are encouraged by their 'spouse/partner'. Three percent (n = 2) of the female respondents indicated **'Great deal of Discouragement'** and 3 percent (n = 3) of the male respondents indicated **'Great deal of Discouragement'**. Two percent (n = 1) of the female respondents indicated **'A little Discouragement'** and 1 percent (n = 1) of the male respondents indicated **'A little Discouragement'**. Eleven percent (n = 7) of the female respondents indicated **'Neither Encouraged/ Discouraged'** and 25 percent (n = 23) of the male respondents indicated **'Neither Encouraged/ Discouraged'**. Twenty-two percent (n = 15) of the female respondents indicated **'A little Encouragement'** and 32 percent (n = 30) of the male respondents indicated **'A little Encouragement'**. Sixty-two percent (n = 41) of the female

respondents indicated **'Great deal of Encouragement'** and 39 percent (n = 37) of the male respondents indicated **'Great deal of Encouragement'**.

The findings indicate that the majority of both female and male students are greatly encouraged by their spouse or partner. However, the minority of both female and male students are a little discouraged by their spouse or partner. The total number of respondents who answered this statement would be few, as most of the students who answered this questionnaire are between the ages of 18 – 23. Therefore, they probably do not have a spouse or partner at this stage in life.

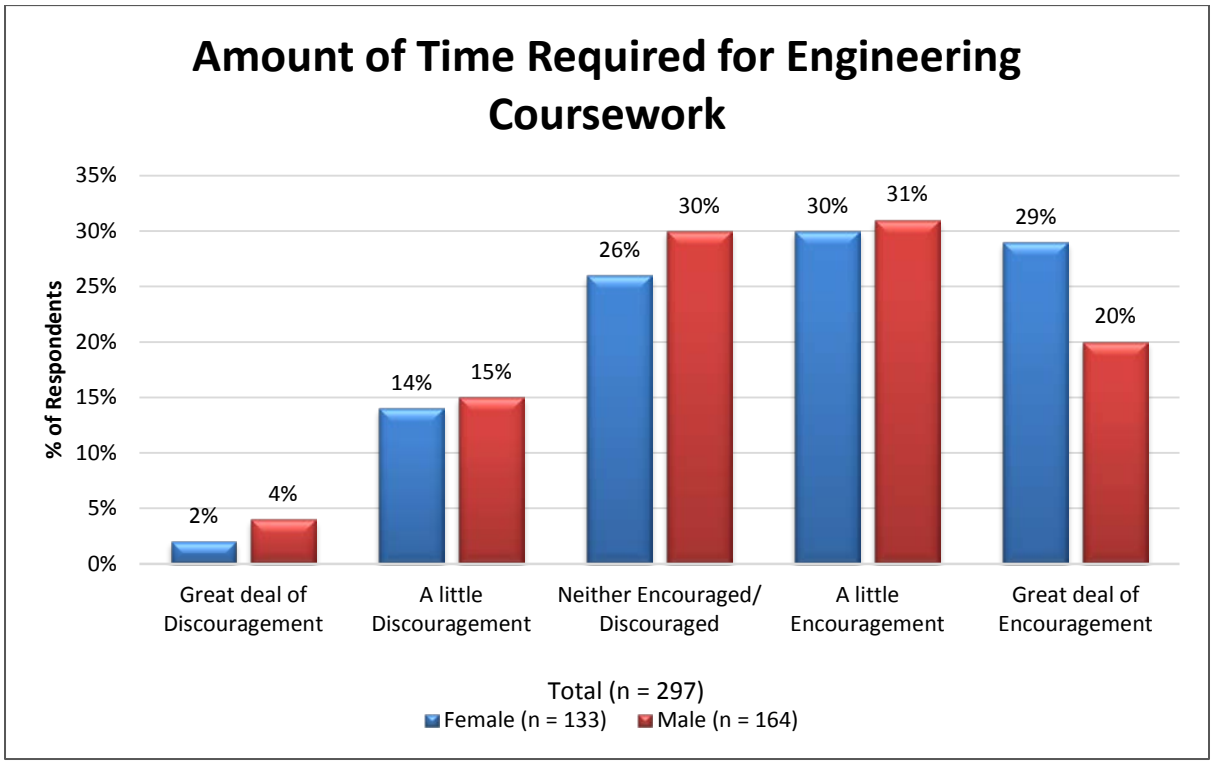

Figure 4.44: Amount of time required for engineering coursework.

Figure 4.44 depicts the total responses (n = 297) received, which is represented by female responses (n = 133) and male responses (n = 164) for their opinion on whether they are encouraged by the 'amount of time required for engineering coursework'. Two percent (n = 2) of the female respondents indicated **'Great deal of Discouragement'** and 4 percent (n = 7) of the male respondents indicated **'Great deal of Discouragement'**. Fourteen percent (n = 19) of the female respondents indicated **'A little Discouragement'** and 15 percent (n = 24) of the male respondents indicated **'A little Discouragement'**. Twenty-six percent (n = 34) of the female respondents indicated **'Neither Encouraged/ Discouraged'** and 30 percent (n = 49) of the male respondents indicated **'Neither Encouraged/ Discouraged'**.

Thirty percent (n = 40) of the female respondents indicated **'A little Encouragement'** and 31 percent (n = 52) of the male respondents indicated **'A little Encouragement'**. Twenty-nine percent (n = 38) of the female respondents indicated **'Great deal of Encouragement'** and 20 percent (n = 32) of the male respondents indicated **'Great deal of Encouragement'**.

The findings indicate that the majority of both female and male students are a little encouraged by the amount of time required for engineering coursework. However, the minority of both female and male students are greatly discouraged by the amount of time required for engineering coursework. However, other discouragements for both male and female students may include that it is too theoretical, not interesting, tutorials were not considered useful, unsuccessful teaching styles or lack of communication (Baillie & Fitzgerald, 2000). However, the workload will have an impact on students' motivation (Kolari et al., 2006).

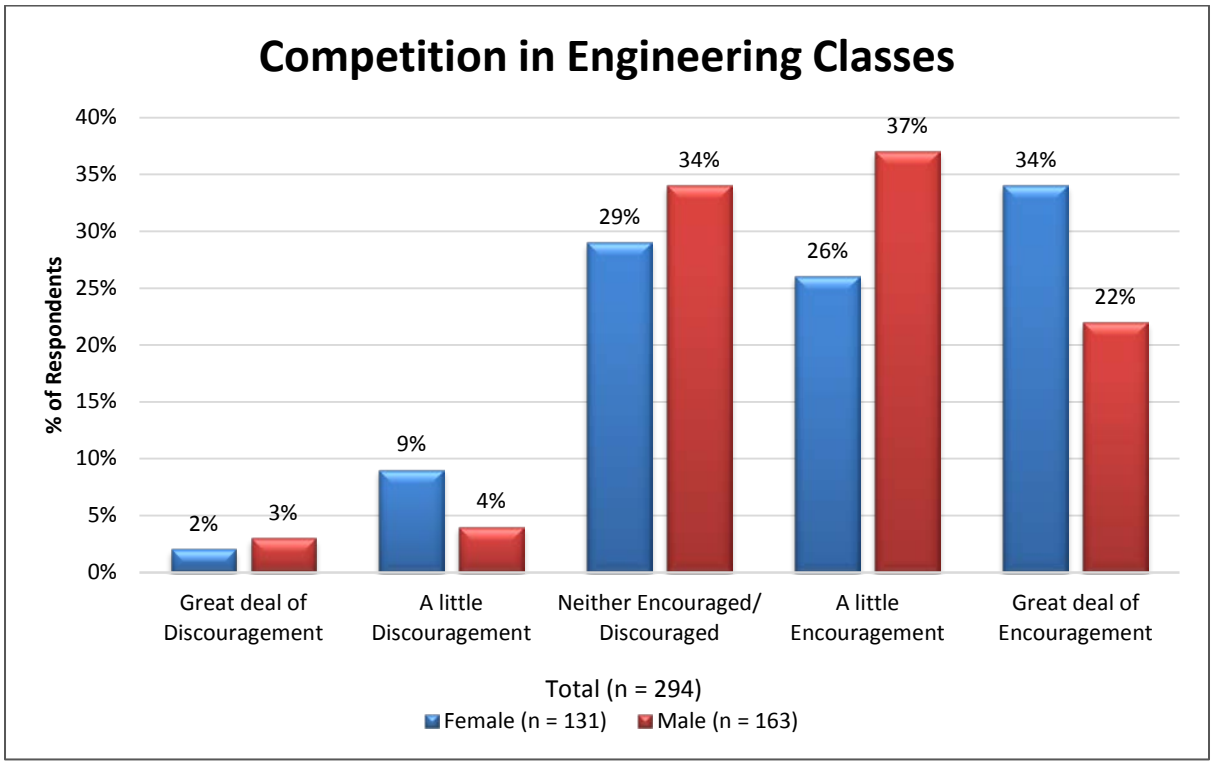

Figure 4.45: Competition in engineering classes.

Figure 4.45 depicts the total responses (n = 294) received, which is represented by female responses (n = 131) and male responses (n = 163) for their opinion on whether they are encouraged by the 'competition in engineering classes'. Two percent (n = 2) of the female respondents indicated **'Great deal of Discouragement'** and 3 percent (n = 4) of the male respondents indicated **'Great deal of Discouragement'**. Nine percent (n = 12) of the

female respondents indicated **'A little Discouragement'** and 4 percent (n = 6) of the male respondents indicated **'A little Discouragement'**. Twenty-nine percent (n = 38) of the female respondents indicated **'Neither Encouraged/ Discouraged'** and 34 percent (n = 56) of the male respondents indicated **'Neither Encouraged/ Discouraged'**. Twenty-six percent (n = 34) of the female respondents indicated **'A little Encouragement'** and 37 percent (n = 61) of the male respondents indicated **'A little Encouragement'**. Thirty-four percent (n = 45) of the female respondents indicated **'Great deal of Encouragement'** and 22 percent (n = 36) of the male respondents indicated **'Great deal of Encouragement'**.

The findings indicate that the majority of female students are greatly encouraged by the competition in engineering classes and the majority of male students are a little encouraged by the competition in engineering classes. However, the minority of both female and male students are greatly discouraged by the competition in engineering classes.

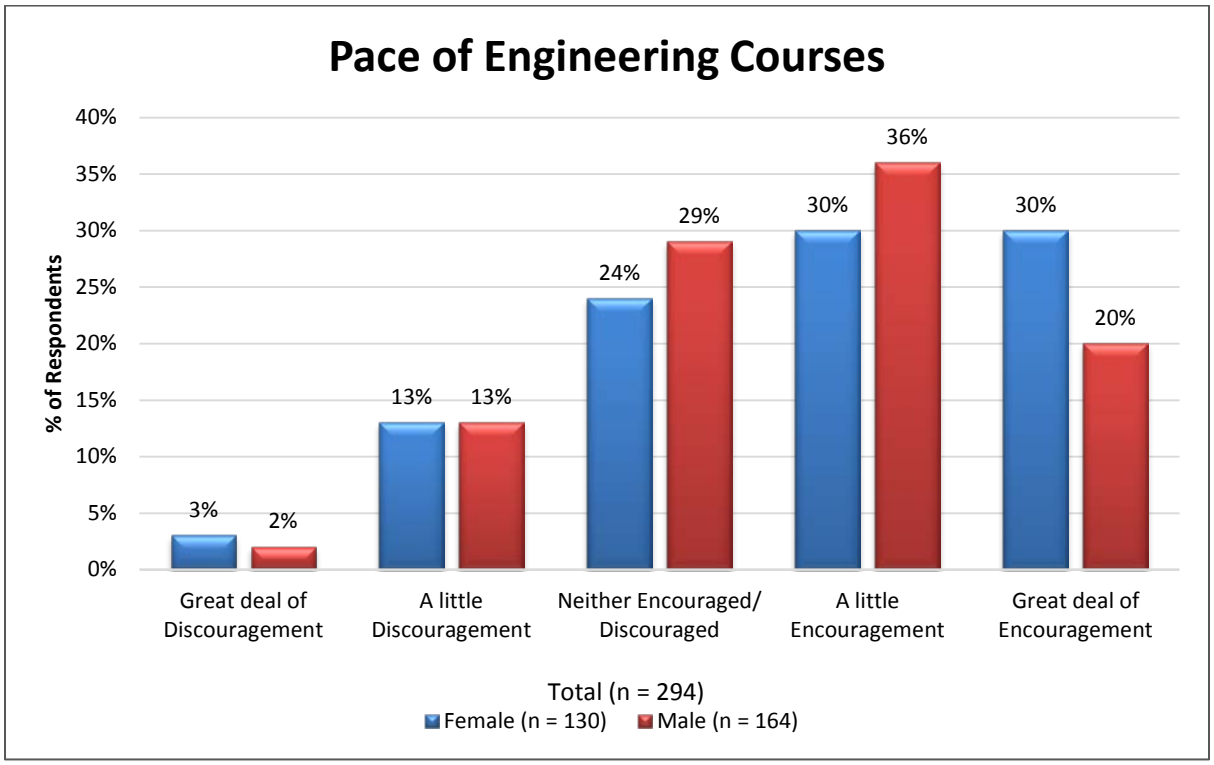

Figure 4.46: Pace of engineering courses.

Figure 4.46 depicts the total responses (n = 294) received, which is represented by female responses (n = 130) and male responses (n = 164) for their opinion on whether they are encouraged by the 'pace of engineering courses'. Three percent (n = 4) of the female respondents indicated **'Great deal of Discouragement'** and 2 percent (n = 3) of the male respondents indicated **'Great deal of Discouragement'**. Thirteen percent (n = 17) of the

female respondents indicated **'A little Discouragement'** and 13 percent (n = 22) of the male respondents indicated **'A little Discouragement'**. Twenty-four percent (n = 31) of the female respondents indicated **'Neither Encouraged/ Discouraged'** and 29 percent (n = 48) of the male respondents indicated **'Neither Encouraged/ Discouraged'**. Thirty percent (n = 39) of the female respondents indicated **'A little Encouragement'** and 36 percent (n = 59) of the male respondents indicated **'A little Encouragement'**. Thirty percent (n = 39) of the female respondents indicated **'Great deal of Encouragement'** and 20 percent (n = 32) of the male respondents indicated **'Great deal of Encouragement'**.

The findings indicate that the majority of both female and male students are a little encouraged by the pace of engineering courses. However, the minority of both female and male students are greatly discouraged by the pace of engineering courses.

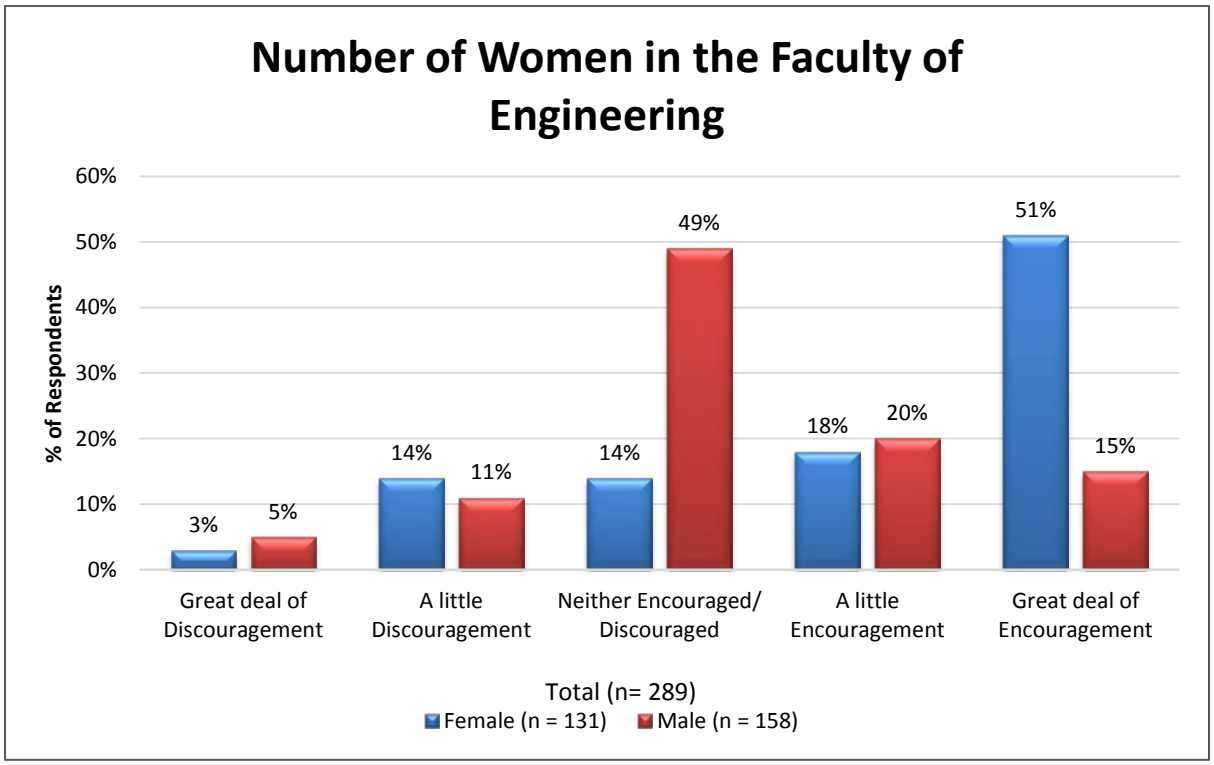

Figure 4.47: Number of women in the faculty of engineering.

Figure 4.47 depicts the total responses (n = 289) received, which is represented by female responses (n = 131) and male responses (n = 158) for their opinion on whether they are encouraged by the 'number of women in the faculty of engineering'. Three percent (n = 4) of the female respondents indicated **'Great deal of Discouragement'** and 5 percent (n = 8) of the male respondents indicated **'Great deal of Discouragement'**. Fourteen percent (n = 18) of the female respondents indicated **'A little Discouragement'** and 11 percent (n = 17)

of the male respondents indicated **'A little Discouragement'**. Fourteen percent (n = 18) of the female respondents indicated **'Neither Encouraged/ Discouraged'** and 49 percent (n = 78) of the male respondents indicated **'Neither Encouraged/ Discouraged'**. Eighteen percent (n = 23) of the female respondents indicated **'A little Encouragement'** and 20 percent (n = 32) of the male respondents indicated **'A little Encouragement'**. Fifty-one percent (n = 68) of the female respondents indicated **'Great deal of Encouragement'** and 15 percent (n = 23) of the male respondents indicated **'Great deal of Encouragement'**.

The findings indicate that the majority of female students are greatly encouraged by the number of women in the faculty of engineering and the majority of male students are neither encouraged/ discouraged by the number of women in the faculty of engineering. However, the minority of both female and male students are greatly discouraged by the number of women in engineering. Therefore, it is important for female students to be in the presence of female academic staff, at a higher education institution. They serve as role models and mentors for female undergraduate and postgraduate students. This will lead to a critical role that the leaders of the engineering departments and university management play, in order to support the importance of attracting and retaining female students (Mills, 2011).

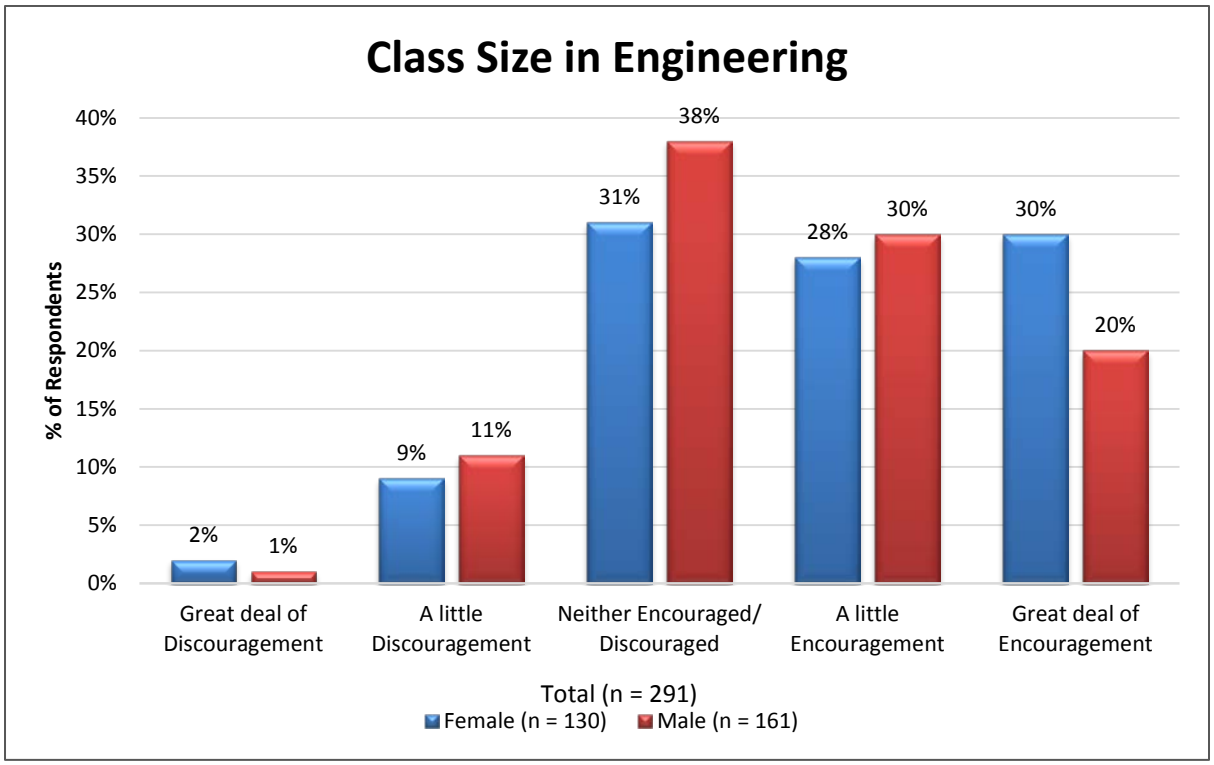

Figure 4.48: Class size in engineering.

Figure 4.48 depicts the total responses (n = 291) received, which is represented by female responses (n = 130) and male responses (n = 161) for their opinion on whether they are encouraged by the 'class size in engineering'. Two percent (n = 3) of the female respondents indicated **'Great deal of Discouragement'** and 1 percent (n = 1) of the male respondents indicated **'Great deal of Discouragement'**. Nine percent (n = 11) of the female respondents indicated **'A little Discouragement'** and 11 percent (n = 18) of the male respondents indicated **'A little Discouragement'**. Thirty-one percent (n = 40) of the female respondents indicated **'Neither Encouraged/ Discouraged'** and 38 percent (n = 62) of the male respondents indicated **'Neither Encouraged/ Discouraged'**. Twenty-eight percent (n = 37) of the female respondents indicated **'A little Encouragement'** and 30 percent (n = 48) of the male respondents indicated **'A little Encouragement'**. Thirty percent (n = 39) of the female respondents indicated **'Great deal of Encouragement'** and 20 percent (n = 32) of the male respondents indicated **'Great deal of Encouragement'**.

The findings indicate that the majority of both female and male students are neither encouraged/ discouraged by the class size in engineering. However, the minority of both female and male students are greatly discouraged by the class size in engineering.

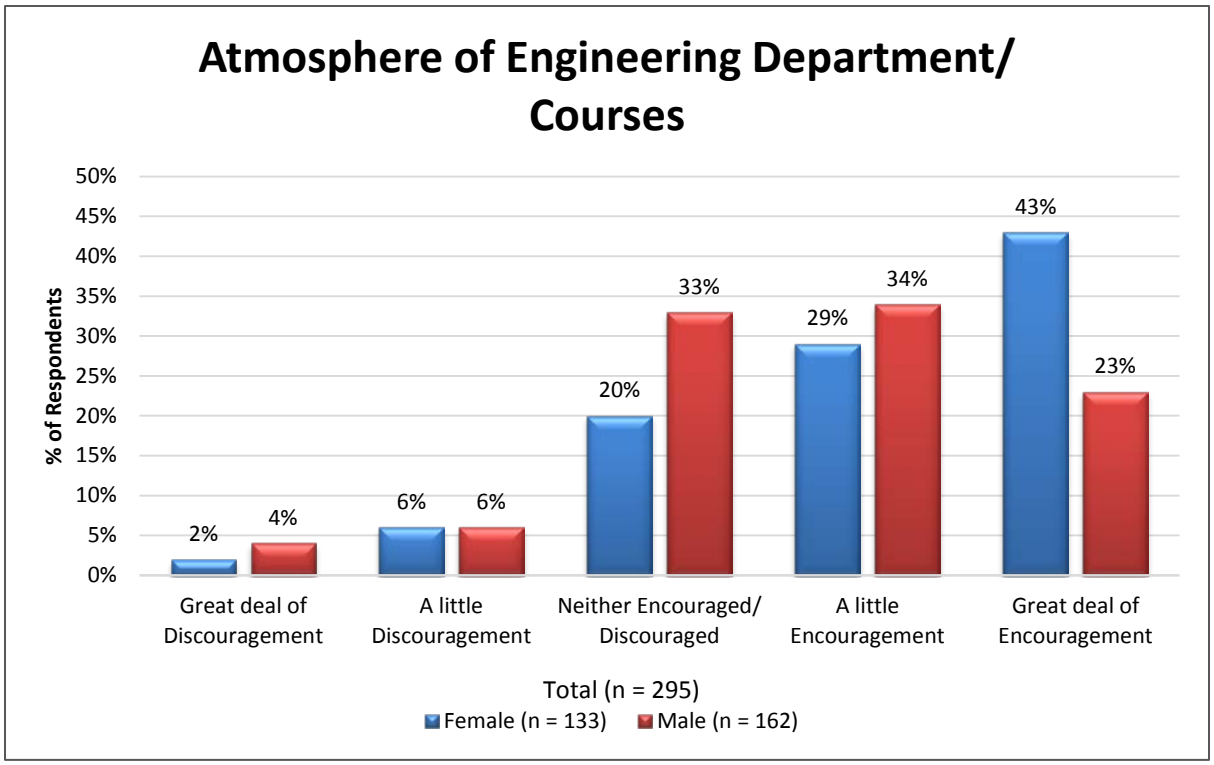

Figure 4.49: Atmosphere of engineering department/courses.

Figure 4.49 depicts the total responses (n = 295) received, which is represented by female responses (n = 133) and male responses (n = 162) for their opinion on whether they are encouraged by the 'atmosphere of engineering department or courses'. Two percent (n = 3) of the female respondents indicated **'Great deal of Discouragement'** and 4 percent (n = 6) of the male respondents indicated **'Great deal of Discouragement'**. Six percent (n = 8) of the female respondents indicated **'A little Discouragement'** and 6 percent (n = 9) of the male respondents indicated **'A little Discouragement'**. Twenty percent (n = 27) of the female respondents indicated **'Neither Encouraged/ Discouraged'** and 33 percent (n = 54) of the male respondents indicated **'Neither Encouraged/ Discouraged'**. Twenty-nine percent (n = 38) of the female respondents indicated **'A little Encouragement'** and 34 percent (n = 55) of the male respondents indicated **'A little Encouragement'**. Forty-three percent (n = 57) of the female respondents indicated **'Great deal of Encouragement'** and 23 percent (n = 38) of the male respondents indicated **'Great deal of Encouragement'**.

The findings indicate that the majority of female students are greatly encouraged by the atmosphere of engineering departments or courses and the majority of male students are a little encouraged atmosphere of engineering department or courses. However, the minority of both female and male students are greatly discouraged by the atmosphere of engineering departments or courses.

Therefore, encouragement is important for female students as they are more likely to drop out during their studies than for male students (Jagacinski, 2013). A few barriers may include inconsistent support and adequate encouragement such as lack of support and knowledge from parents, low teacher inspiration and support, lack of extracurricular opportunities, lack of knowledge regarding successful engineering careers, anxiety during tests, past performance and lack of interest in certain subjects (Cadaret et al., 2016).

Figures 4.50 – 4.60 depicts the level of agreement for both female and male students that could result into encouragement regarding their engineering courses. Some statements were left out due to misunderstanding the statement. The findings will be elaborated below.

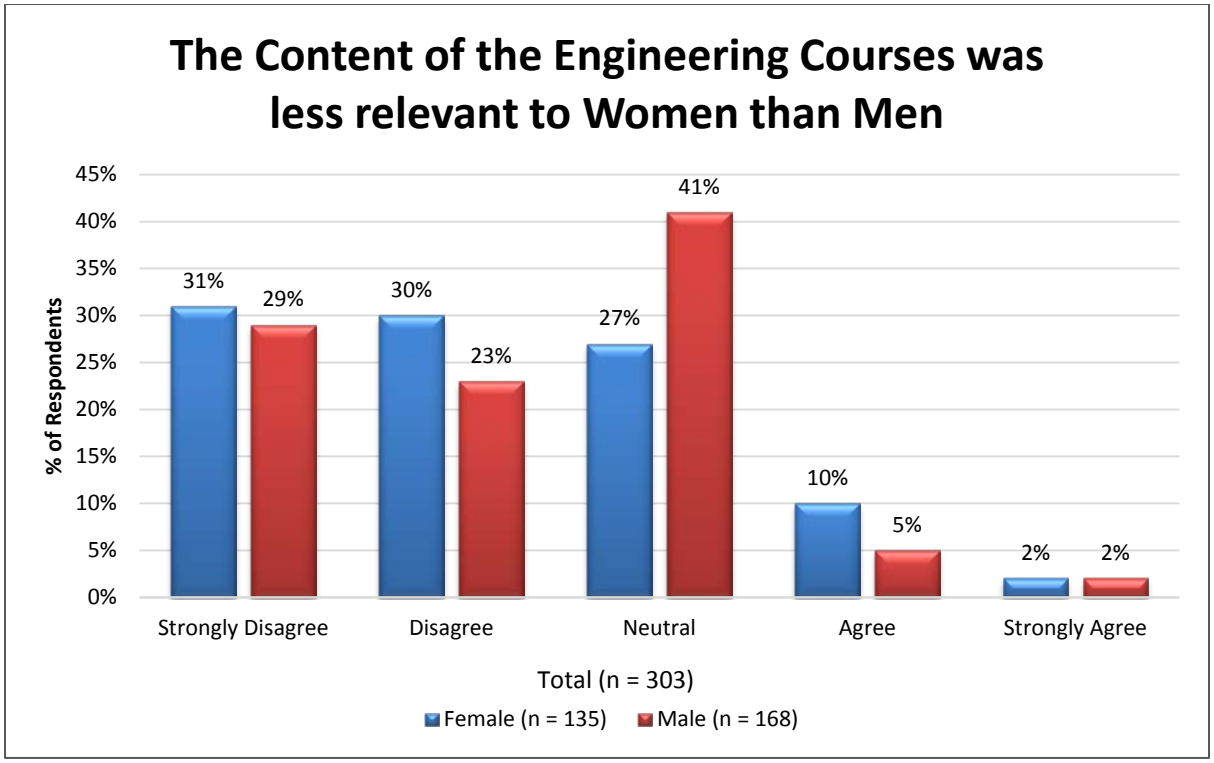

Figure 4.50: The content of the engineering courses was less relevant to women than men.

Figure 4.50 depicts the total responses (n = 303) received from the female responses (n = 135) and male responses (n = 168) for their opinion on 'the content of the engineering courses was less relevant to women than men'. Thirty-one percent (n = 43) of the female respondents indicated **'Strongly Disagree'** and 29 percent (n = 48) of the male respondents indicated **'Strongly Disagree'**. Thirty percent (n = 40) of the female respondents indicated **'Disagree'** and 23 percent (n = 39) of the male respondents indicated **'Disagree'**. Twenty-seven percent (n = 36) of the female respondents indicated **'Neutral'** and 41 percent (n = 69) of the male respondents indicated **'Neutral'**. Ten percent (n = 14) of the female respondents indicated **'Agree'** and 5 percent (n = 9) of the male respondents indicated **'Agree'**. Two percent (n = 2) of the female respondents indicated **'Strongly Agree'** and 2 percent (n = 3) of the male respondents indicated **'Strongly Agree'**.

The findings indicate that the majority of female students strongly disagree that the content of their engineering courses was less relevant to women than men and the majority of male students were neutral towards this statement. However, the minority of both female and male students strongly agree with this statement. The high response rate on 'Neutral' from both genders could be to avoid negative feelings associated with their conflicting feelings towards this statement or they are unsure regarding the statement.

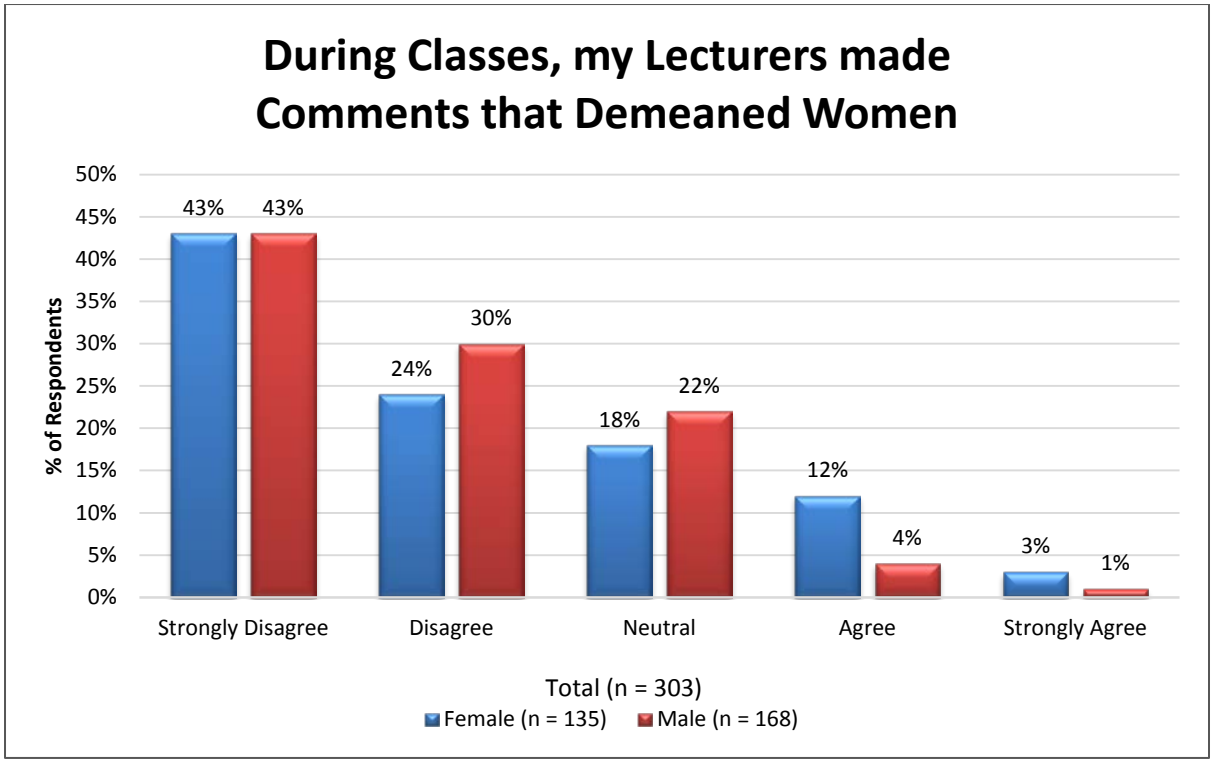

Figure 4.51: During classes, my lecturers made comments that demeaned women.

Figure 4.51 depicts the total responses (n = 303) received from the female responses (n = 135) and male responses (n = 168) for their opinion whether 'during classes, my lecturers made comments that demeaned women'. Forty-three percent (n = 58) of the female respondents indicated **'Strongly Disagree'** and 43 percent (n = 72) of the male respondents indicated **'Strongly Disagree'**. Twenty-four percent (n = 33) of the female respondents indicated **'Disagree'** and 30 percent (n = 50) of the male respondents indicated **'Disagree'**. Eighteen percent (n = 24) of the female respondents indicated **'Neutral'** and 22 percent (n = 37) of the male respondents indicated **'Neutral'**. Twelve percent (n = 16) of the female respondents indicated **'Agree'** and 4 percent (n = 7) of the male respondents indicated **'Agree'**. Three percent (n = 4) of the female respondents indicated **'Strongly Agree'** and 1 percent (n = 2) of the male respondents indicated **'Strongly Agree'**.

The findings indicate that the majority of both female and male students strongly disagree that during classes, their lecturers made comments that demeaned women. However, the minority of both female and male students strongly agree with this statement.

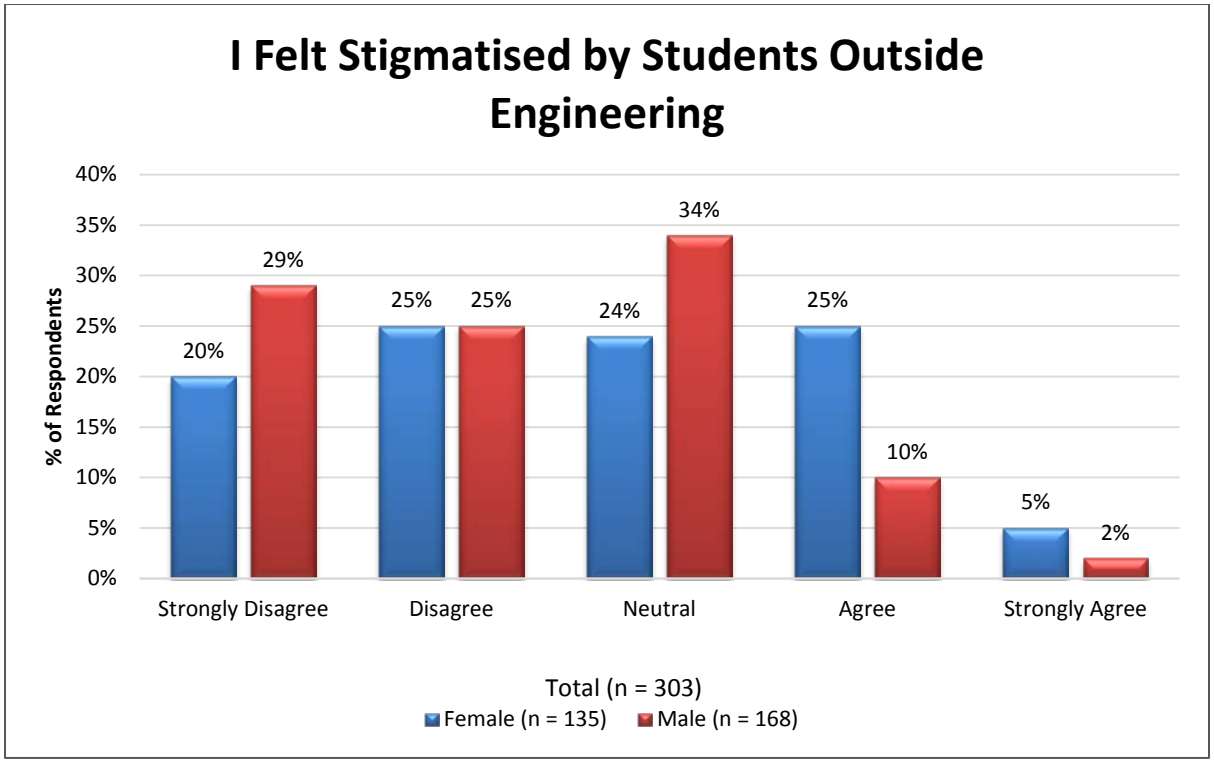

Figure 4.52: I felt stigmatised by students outside engineering.

Figure 4.52 depicts the total responses (n = 303) received from the female responses (n = 135) and male responses (n = 168) for their opinion on 'I felt stigmatised by students outside engineering'. Twenty percent (n = 27) of the female respondents indicated **'Strongly Disagree'** and 29 percent (n = 49) of the male respondents indicated **'Strongly Disagree'**. Twenty-five percent (n = 34) of the female respondents indicated **'Disagree'** and 25 percent (n = 42) of the male respondents indicated **'Disagree'**. Twenty-four percent (n = 33) of the female respondents indicated **'Neutral'** and 34 percent (n = 57) of the male respondents indicated **'Neutral'**. Twenty-five percent (n = 34) of the female respondents indicated **'Agree'** and 10 percent (n = 17) of the male respondents indicated **'Agree'**. Five percent (n = 7) of the female respondents indicated **'Strongly Agree'** and 2 percent (n = 3) of the male respondents indicated **'Strongly Agree'**.

The findings indicate that the majority of female students disagree and agree that they felt stigmatised by students outside engineering and the majority of male students were neutral towards this statement. However, the minority of both female and male students strongly agree with this statement. The high response rate on 'Neutral' from both genders could be due to misinterpretation of the word 'stigmatised'. For most students that answered the survey, English is their second language. Therefore, easy readable statements should have been used.

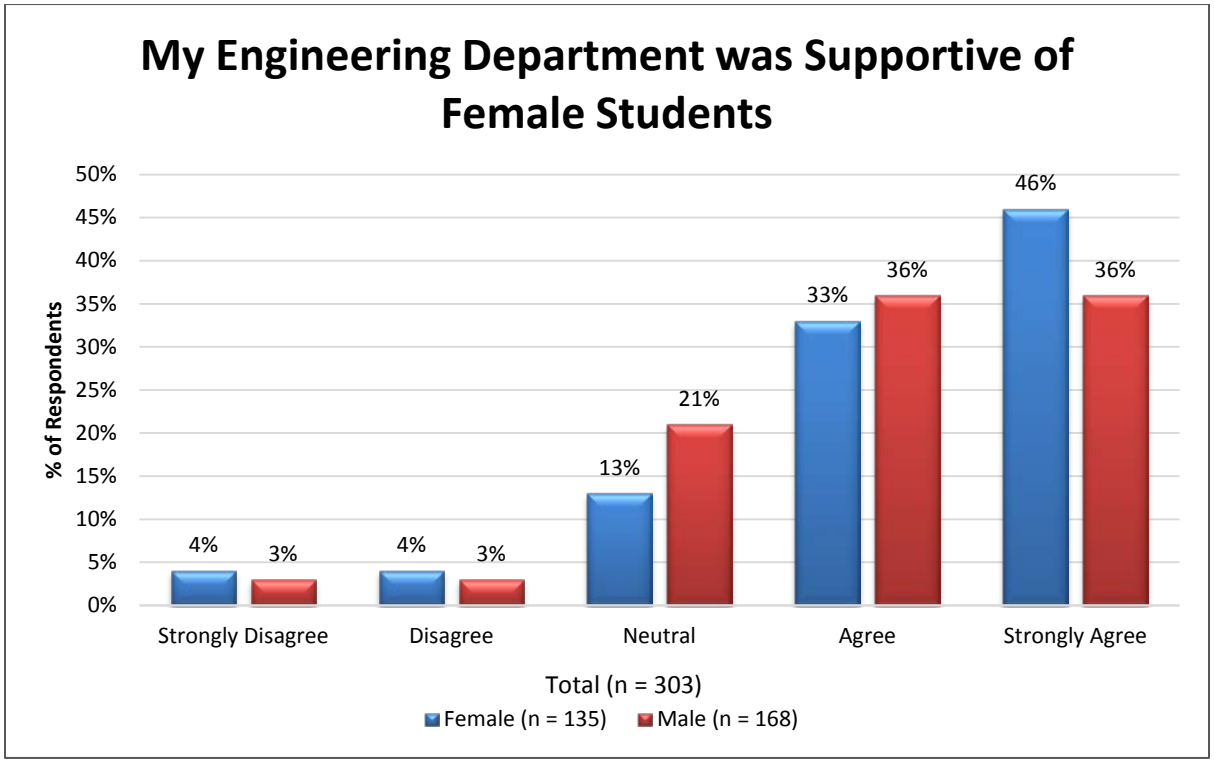

Figure 4.53: My engineering department was supportive of female students.

Figure 4.53 depicts the total responses (n = 303) received from the female responses (n = 135) and male responses (n = 168) for their opinion whether 'my engineering department was supportive of female students'. Four percent (n = 6) of the female respondents indicated **'Strongly Disagree'** and 3 percent (n = 5) of the male respondents indicated **'Strongly Disagree'**. Four percent (n = 5) of the female respondents indicated **'Disagree'** and 3 percent (n = 5) of the male respondents indicated **'Disagree'**. Thirteen percent (n = 18) of the female respondents indicated **'Neutral'** and 21 percent (n = 36) of the male respondents indicated **'Neutral'**. Thirty-three percent (n = 44) of the female respondents indicated **'Agree'** and 36 percent (n = 61) of the male respondents indicated **'Agree'**. Forty-six percent (n = 62) of the female respondents indicated **'Strongly Agree'** and 36 percent (n = 61) of the male respondents indicated **'Strongly Agree'**.

The findings indicate that the majority of both female and male students strongly agree that they engineering department was supportive of female students. However, the minority of both female and male students strongly disagree with this statement. The relatively high response rate on 'Neutral' from both genders could be to avoid negative feelings associated with their conflicting feelings towards this statement or they are unsure regarding this statement.

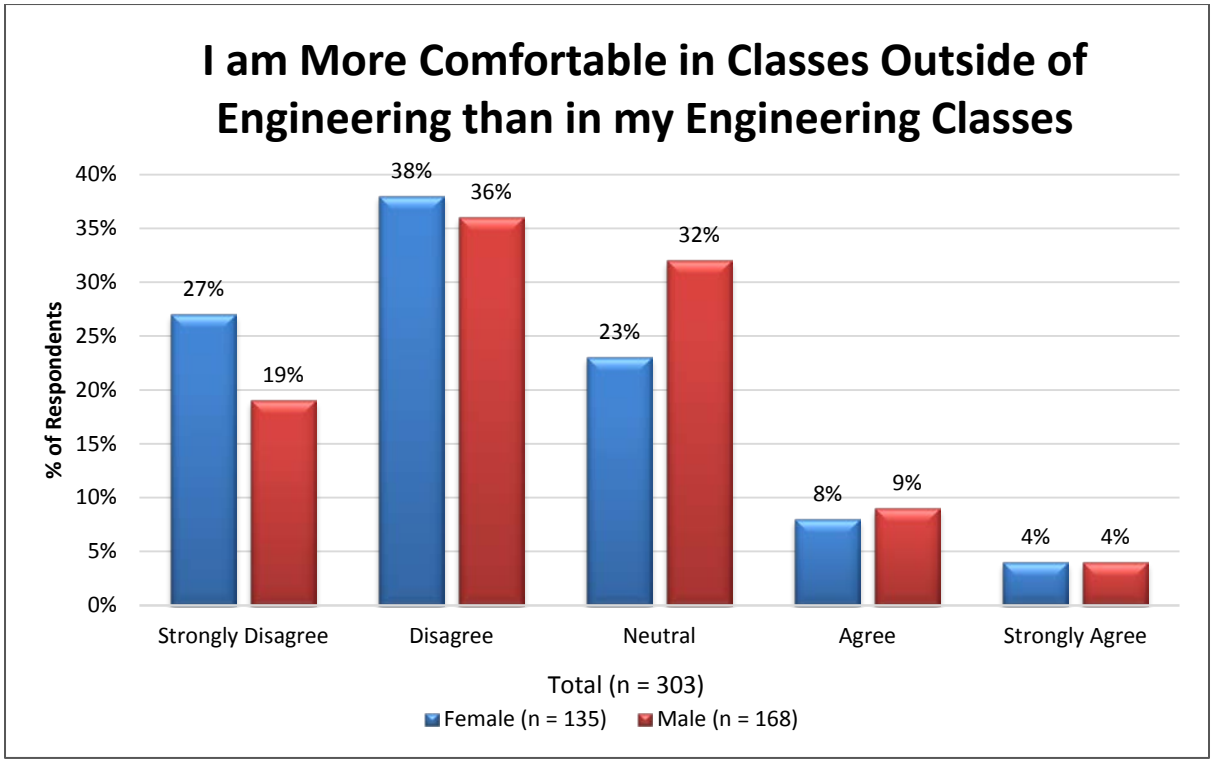

Figure 4.54: I am more comfortable in classes outside of engineering than in my engineering classes.

Figure 4.54 depicts the total responses (n = 303) received from the female responses (n = 135) and male responses (n = 168) for their opinion whether 'I am more comfortable in classes outside of engineering than in my engineering classes'. Twenty-seven percent (n = 36) of the female respondents indicated **'Strongly Disagree'** and 19 percent (n = 32) of the male respondents indicated **'Strongly Disagree'**. Thirty-eight percent (n = 52) of the female respondents indicated **'Disagree'** and 36 percent (n = 60) of the male respondents indicated **'Disagree'**. Twenty-three percent (n = 31) of the female respondents indicated **'Neutral'** and 32 percent (n = 55) of the male respondents indicated **'Neutral'**. Eight percent (n = 11) of the female respondents indicated **'Agree'** and 9 percent (n = 15) of the male respondents indicated **'Agree'**. Four percent (n = 5) of the female respondents indicated **'Strongly Agree'** and 4 percent (n = 6) of the male respondents indicated **'Strongly Agree'**.

The findings indicate that the majority of both female and male students disagree that they feel more comfortable in classes in departments outside of engineering than in engineering classes. However, the minority of both female and male students strongly agree with this statement. The high response rate on 'Neutral' from both genders could be to avoid negative feelings associated with their conflicting feelings towards this statement or they are unsure regarding this statement.

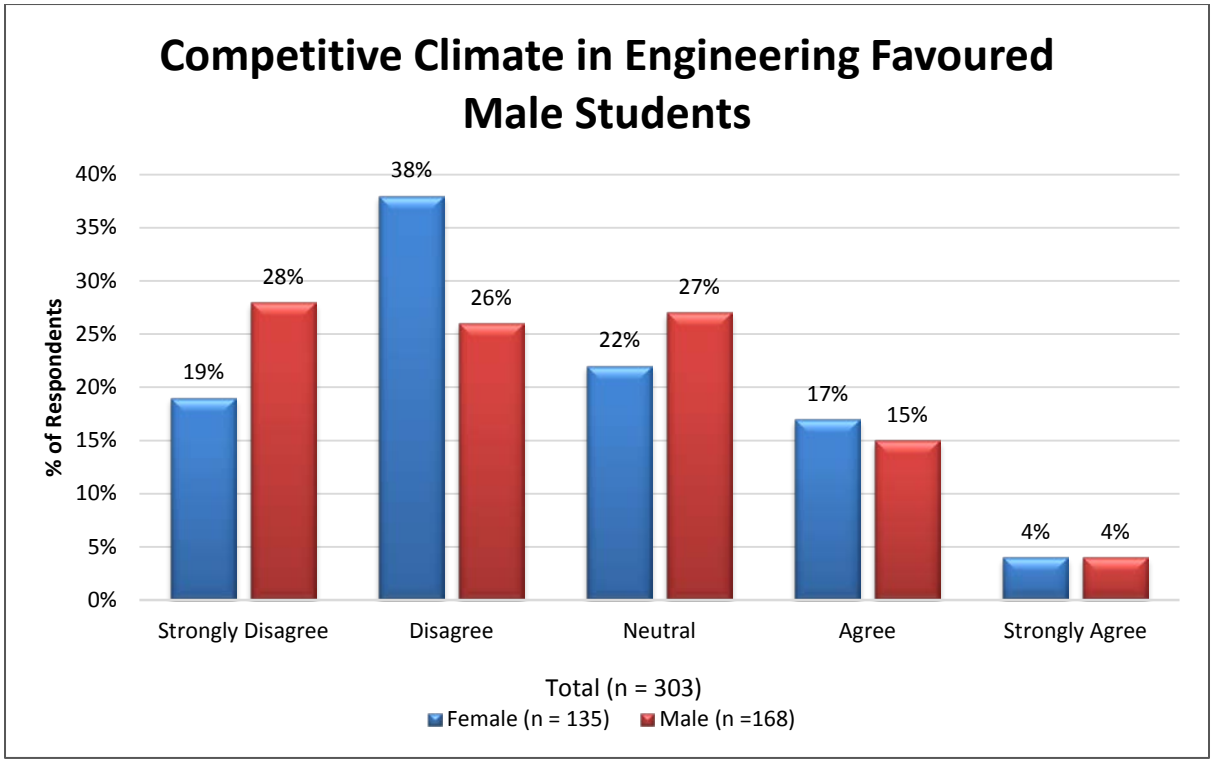

Figure 4.55: Competitive climate in engineering favoured male students.

Figure 4.55 depicts the total responses (n = 303) received from the female responses (n = 135) and male responses (n = 168) for their opinion whether the 'competitive climate in engineering favoured male students'. Nineteen percent (n = 26) of the female respondents indicated **'Strongly Disagree'** and 28 percent (n = 47) of the male respondents indicated **'Strongly Disagree'**. Thirty-eight percent (n = 51) of the female respondents indicated **'Disagree'** and 26 percent (n = 44) of the male respondents indicated **'Disagree'**. Twenty-two percent (n = 30) of the female respondents indicated **'Neutral'** and 27 percent (n = 45) of the male respondents indicated **'Neutral'**. Seventeen percent (n = 23) of the female respondents indicated **'Agree'** and 15 percent (n = 26) of the male respondents indicated **'Agree'**. Four percent (n = 5) of the female respondents indicated **'Strongly Agree'** and 4 percent (n = 6) of the male respondents indicated **'Strongly Agree'**.

The findings indicate that the majority of female students disagree that the competitive climate in engineering favoured male students and the majority of male students strongly disagree with this statement. However, the minority of both female and male students strongly agree with this statement. The high response rate on 'Neutral' from both genders could be to avoid negative feelings associated with their conflicting feelings towards this statement or they are unsure regarding this statement.

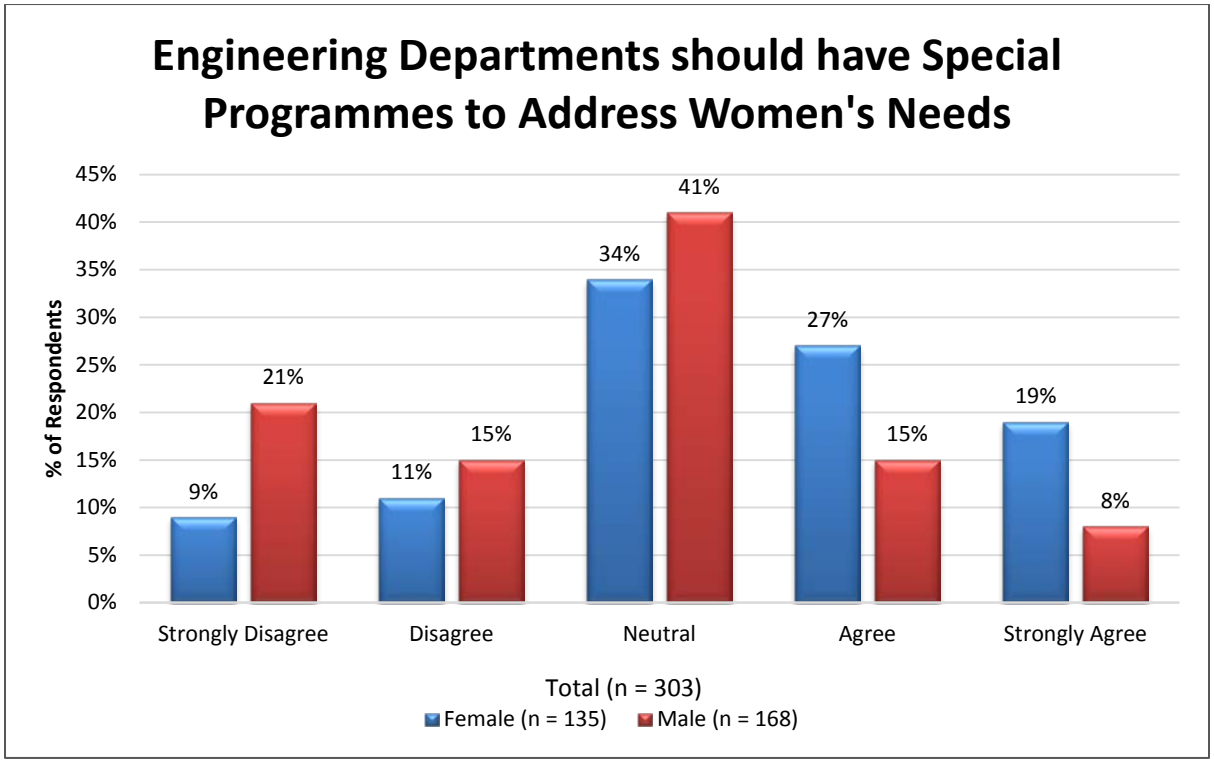

Figure 4.56: Engineering departments should have special programmes to address women's needs.

Figure 4.56 depicts the total responses (n = 303) received from the female responses (n = 135) and male responses (n = 168) for their opinion whether 'engineering departments should have special programmes to address women's needs'. Nine percent (n = 12) of the female respondents indicated **'Strongly Disagree'** and 21 percent (n = 36) of the male respondents indicated **'Strongly Disagree'**. Eleven percent (n = 15) of the female respondents indicated **'Disagree'** and 15 percent (n = 25) of the male respondents indicated **'Disagree'**. Thirty-four percent (n = 46) of the female respondents indicated **'Neutral'** and 41 percent (n = 68) of the male respondents indicated **'Neutral'**. Twenty-seven percent (n = 37) of the female respondents indicated **'Agree'** and 15 percent (n = 26) of the male respondents indicated **'Agree'**. Nineteen percent (n = 25) of the female respondents indicated **'Strongly Agree'** and 8 percent (n = 13) of the male respondents indicated **'Strongly Agree'**.

The findings indicate that the majority of both female and male students felt neutral that engineering departments should have special programmes to address women's needs. However, the minority of female students strongly disagree towards this statement and the minority of male students strongly agree with this statement. The high response rate on

'Neutral' from both genders could be to avoid negative feelings associated with their conflicting feelings towards this statement or they are unsure regarding this statement.

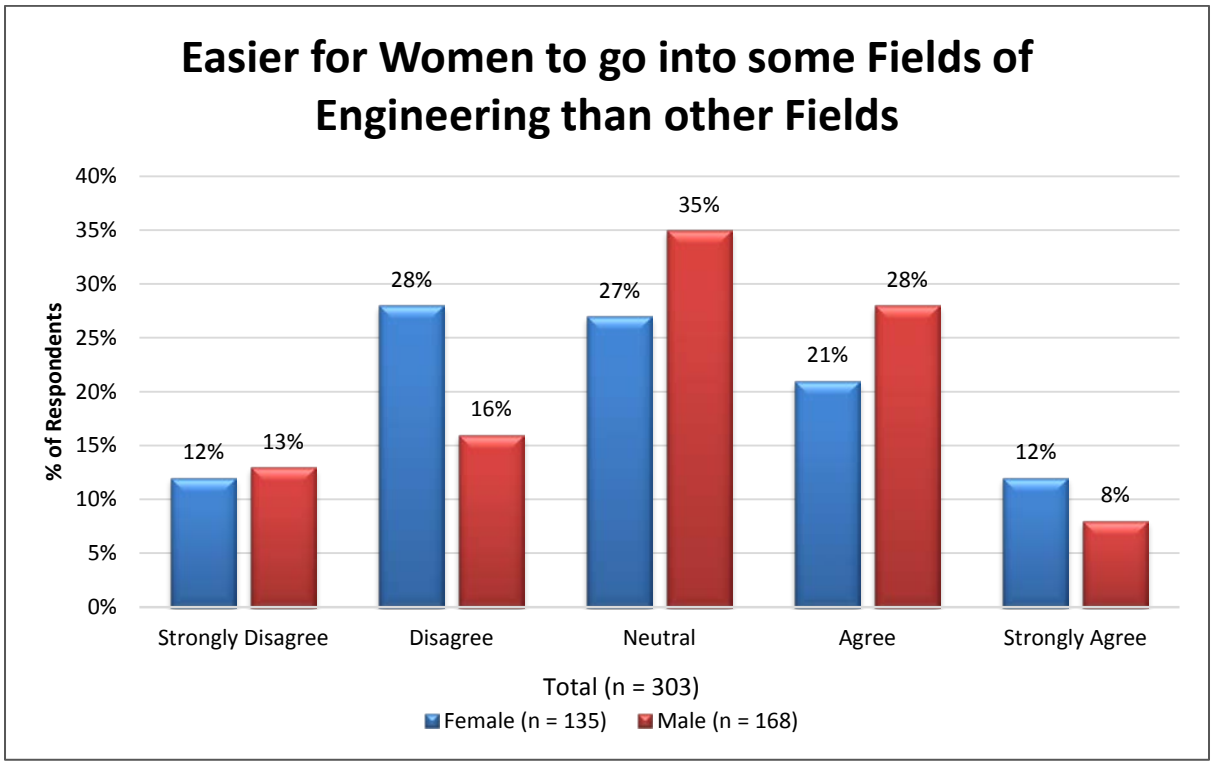

Figure 4.57: Easier for women to go into some fields of engineering than other fields.

Figure 4.57 depicts the total responses (n = 303) received from the female responses (n = 135) and male responses (n = 168) for their opinion whether it is 'easier for women to go into some fields of engineering than other fields'. Twelve percent (n = 16) of the female respondents indicated **'Strongly Disagree'** and 13 percent (n = 22) of the male respondents indicated **'Strongly Disagree'**. Twenty-eight percent (n = 38) of the female respondents indicated **'Disagree'** and 16 percent (n = 27) of the male respondents indicated **'Disagree'**. Twenty-seven percent (n = 36) of the female respondents indicated **'Neutral'** and 35 percent (n = 59) of the male respondents indicated **'Neutral'**. Twenty-one percent (n = 29) of the female respondents indicated **'Agree'** and 28 percent (n = 47) of the male respondents indicated **'Agree'**. Twelve percent (n = 16) of the female respondents indicated **'Strongly Agree'** and 8 percent (n = 13) of the male respondents indicated **'Strongly Agree'**.

The findings indicate that the majority of female students disagree that it is easier for women to go into some fields of engineering compared to other fields and the majority of male students indicated neutral for this statement. However, the minority of both female and male students strongly agree with this statement. The high response rate on 'Neutral' from both

genders could be to avoid negative feelings associated with their conflicting feelings towards this statement or they are unsure regarding this statement.

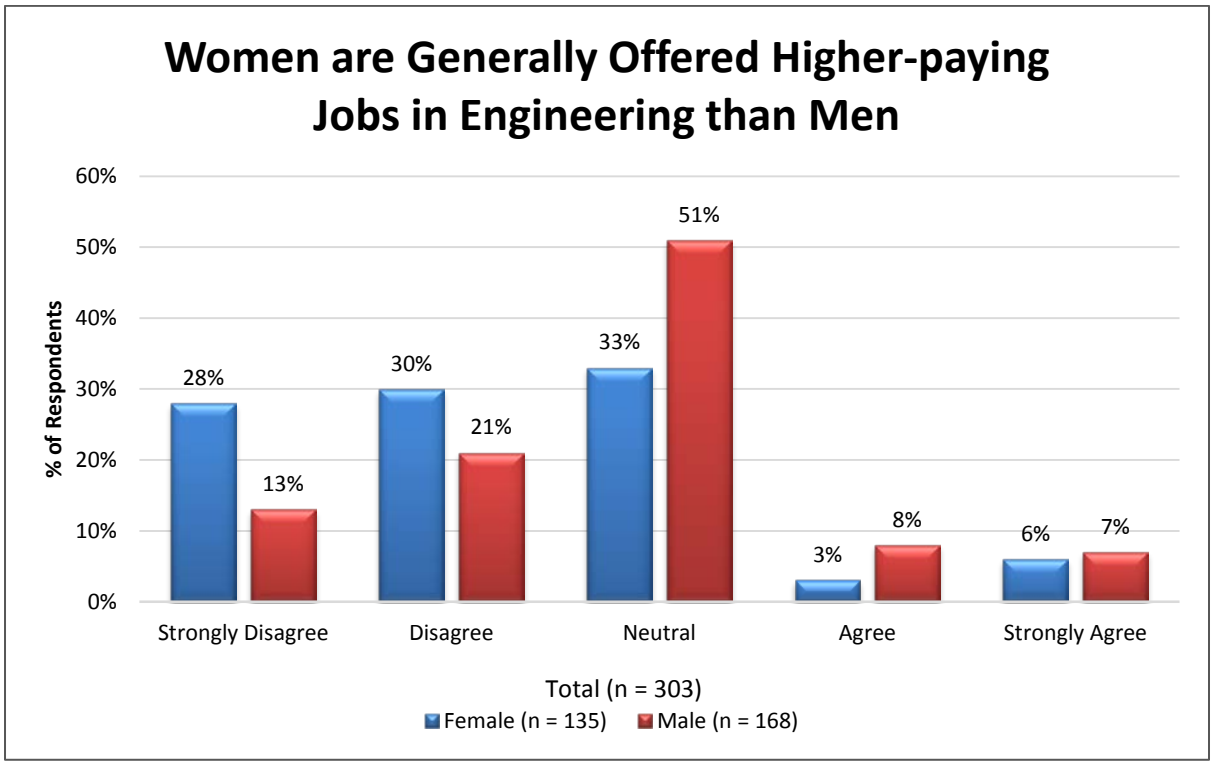

Figure 4.58: Women are generally offered higher-paying jobs in engineering than men.

Figure 4.58 depicts the total responses (n = 303) received from the female responses (n = 135) and male responses (n = 168) for their opinion whether 'women are generally offered higher-paying jobs in engineering than men'. Twenty-eight percent (n = 38) of the female respondents indicated **'Strongly Disagree'** and 13 percent (n = 22) of the male respondents indicated **'Strongly Disagree'**. Thirty percent (n = 40) of the female respondents indicated **'Disagree'** and 21 percent (n = 35) of the male respondents indicated **'Disagree'**. Thirty-three percent (n = 44) of the female respondents indicated **'Neutral'** and 51 percent (n = 86) of the male respondents indicated **'Neutral'**. Three percent (n = 4) of the female respondents indicated **'Agree'** and 8 percent (n = 14) of the male respondents indicated **'Agree'**. Six percent (n = 9) of the female respondents indicated **'Strongly Agree'** and 7 percent (n = 11) of the male respondents indicated **'Strongly Agree'**.

The findings indicate that the majority of both female and male students indicated neutral that women are generally offered higher-paying jobs in engineering than men. The high response rate on 'Neutral' from both genders could be to avoid negative feelings associated with their conflicting feelings towards this statement or they are unsure regarding this

statement. However, the minority of female students agree towards this statement and the minority of male students strongly agree with this statement. However, women generally are more qualified than men, but they are still earning less (Chamie, 2014).

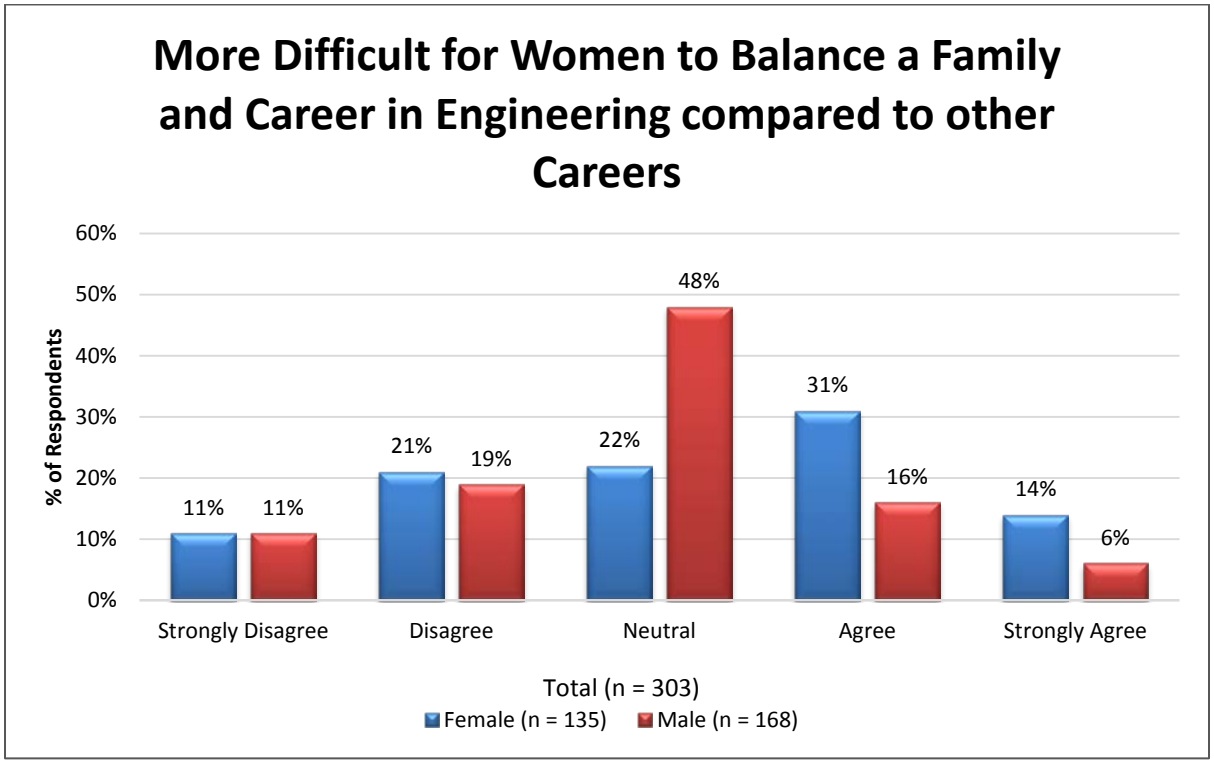

Figure 4.59: More difficult for women to balance a family and career in engineering compared to other careers.

Figure 4.59 depicts the total responses (n = 303) received from the female responses (n = 135) and male responses (n = 168) for their opinion whether it is 'more difficult for women to balance a family and career in engineering compared to other careers'. Eleven percent (n = 15) of the female respondents indicated **'Strongly Disagree'** and 11 percent (n = 18) of the male respondents indicated **'Strongly Disagree'**. Twenty-one percent (n = 29) of the female respondents indicated **'Disagree'** and 19 percent (n = 32) of the male respondents indicated **'Disagree'**. Twenty-two percent (n = 30) of the female respondents indicated **'Neutral'** and 48 percent (n = 81) of the male respondents indicated **'Neutral'**. Thirty-one percent (n = 42) of the female respondents indicated **'Agree'** and 16 percent (n = 27) of the male respondents indicated **'Agree'**. Fourteen percent (n = 19) of the female respondents indicated **'Strongly Agree'** and 6 percent (n = 10) of the male respondents indicated **'Strongly Agree'**.

The findings indicate that the majority of female students indicated neutral that it is more difficult for women to balance a family and career in engineering compared to other careers and the majority of male students indicated that they agree with this statement. However, the minority of female students indicated that they strongly disagree with this statement and the minority of male students strongly agree with this statement. The high response rate on 'Neutral' from the male students could be to avoid negative feelings associated with their conflicting feelings towards this statement or they are unsure regarding this statement.

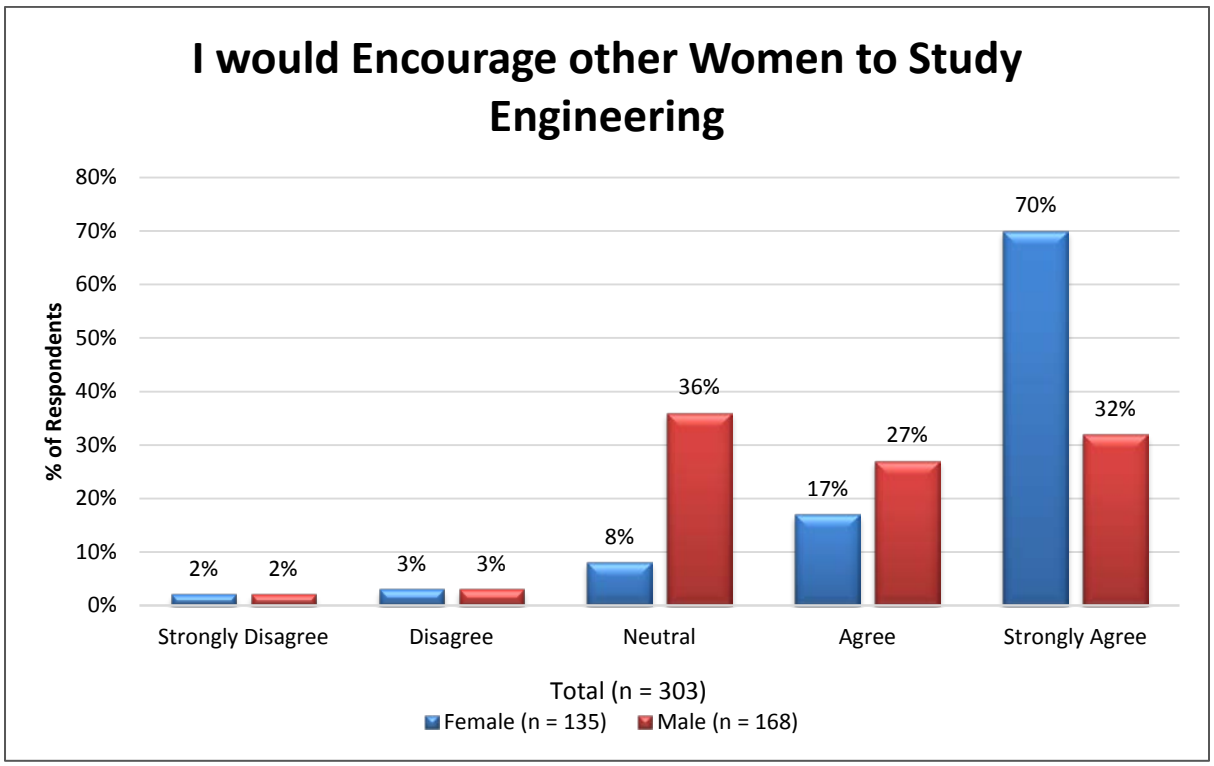

Figure 4.60: I would encourage other women to study engineering.

Figure 4.60 depicts the total responses (n = 303) received from the female responses (n = 135) and male responses (n = 168) for their opinion whether 'I would encourage other women to study engineering'. Two percent (n = 2) of the female respondents indicated **'Strongly Disagree'** and 2 percent (n = 4) of the male respondents indicated **'Strongly Disagree'**. Three percent (n = 4) of the female respondents indicated **'Disagree'** and 3 percent (n = 5) of the male respondents indicated **'Disagree'**. Eight percent (n = 11) of the female respondents indicated **'Neutral'** and 36 percent (n = 60) of the male respondents indicated **'Neutral'**. Seventeen percent (n = 23) of the female respondents indicated **'Agree'** and 27 percent (n = 46) of the male respondents indicated **'Agree'**. Seventy percent (n = 95) of the female respondents indicated **'Strongly Agree'** and 32 percent (n = 53) of the male respondents indicated **'Strongly Agree'**.

The findings indicate that the majority of female students strongly agree that they would encourage other women to study engineering and the majority of male students indicated neutral for this statement. However, the minority of both female and male students strongly disagree with this statement. The high response rate on 'Neutral' from the male students could be to avoid negative feelings associated with their conflicting feelings towards this statement or they are unsure regarding this statement.

Variable	T-tests; Grouping: Gender								
	Mean (1)	Mean (2)	t-value	df	p	Valid N (1)	Valid N (2)	Std Dev. (1)	Std Dev. (2)
Studies	2.94	2.78	2.6472	301	0.00854	135	168	0.55390	0.47869

Table 4.5: T-tests on Gender with Studies variables.

Table 4.5 indicates a t-test conducted on gender regarding experience during their studies. $p < 0.05$ which indicates that a statistical, significant difference between gender with regard to experience during their studies. The mean for both female and male students is three, indicating that the average for both genders indicated neutral on the above variables. The Cronbach Alpha for this construct was established as 0.7 indicating low acceptable reliability. Cohen's D was established as 0.31 indicating medium effect.

	Female (n = 135)		Male (n = 168)		Total (n = 303)	
Why do you participate in a study or support group?	**Female Number**	**Female %**	**Male Number**	**Male %**	**Total Number**	**Total %**
Socialising with other women in engineering	71	11%	29	4%	100	7%
Socialising with men in engineering	18	3%	34	5%	52	4%
Getting advice or mentoring about engineering	73	11%	76	10%	149	11%
Talking about issues of concern in engineering	72	11%	79	11%	151	11%
Getting help with engineering modules	98	15%	100	14%	198	14%
Helping others	61	10%	83	11%	144	11%
Getting career counselling or information	38	6%	36	5%	74	5%
Learning about a topic of interest related to engineering	38	6%	77	11%	115	8%
Being in a supportive atmosphere	66	10%	69	9%	135	10%
Learning more about specific fields in engineering	46	7%	56	7%	102	7%
Getting to know the faculty in engineering	40	6%	51	7%	91	7%
Earning money	17	3%	39	5%	56	4%
Other	3	1%	6	1%	9	1%

Table 4.6: Frequency count on why did you participate in a study or support group.

Table 4.6 indicate that the majority of female students (n = 73) indicated that they participate in a study or support group to get advice or mentoring and the majority of male students (n = 198) indicated that they participate in a study or support group to get assistance with engineering modules. However, the minority of both female and male students indicated that there are other reasons for participating in a study or support group. However, during chapter two it has been mentioned that barriers for students may include inconsistent support such as low teacher support, lack of inspiration, lack of extracurricular opportunities or lack of interest in certain subjects (Cadaret et al., 2016). Female students experience difficulty in interpersonal relationships and have to make extra efforts in order to adapt their study methods. Thus, those female students who were assigned a graduate student as a mentor, their relationship contributed to their academic and social initiation improved (Hosaka, 2010).

The following sub-section will summarise the research findings of Section 4.

4.3.2.7. Summary of Research Findings in Section 4

Section 4 – Most Influential People During Studies was used to collect data regarding the importance of the most influential people and other aspects that could result into encouraging or discouraging students during their studies. The findings indicate that the majority of both female and male students are encouraged by a member of their family, someone they know in a science/ mathematics or engineering field, employment opportunities, salary potential, interest in the subject matter, their grades and atmosphere of engineering departments or courses.

Ranking	Female Students	Male Students
1	Mother	Mother
2	Employment opportunities	Employment opportunities
3	Interest in subject matter in engineering	Father
4	Someone who works in a science, mathematics or engineering field	Interest in subject matter in engineering
5	Father	Spouse/ Partner

Table 4.7: Top five most significant source of encouragement.

Students were requested to indicate the single most significant source of encouragement and Table 4.7 above indicates the top five aspects for female students and the top five aspects for male students. Both genders indicated that the single most significant source of

encouragement is their mother and secondly employment opportunities. The findings clearly indicate that there is no difference between genders regarding encouragement.

Ranking	Female Students	Male Students
1	Amount of time required for engineering coursework	Grades
2	Grades	Amount of time required for engineering coursework
3	Number of women in Engineering Faculty	Pace of engineering courses
4	Competition in engineering classes	Employment opportunities
5	Pace of engineering courses	Quality of teaching in engineering

Table 4.8: Top five most significant source of discouragement.

Students were requested to indicate the single most significant source of discouragement and Table 4.8 above indicates the top five aspects for female students and the top five aspects for male students. Female students indicated the single most significant source of discouragement is the amount of time required for engineering coursework and secondly their grades. However, the male students indicate their grades are the single most significant source of discouragement and secondly the amount of time required for engineering coursework. The findings clearly indicate that there is no difference between genders regarding discouragement when considering the top two reasons.

The findings indicate that during their studies, female students disagree that the content is less relevant to female students then male students, the lecturers do not make comments that demeaned female students, the engineering department is supportive towards female students and female students would definitely encourage other females to study engineering. Female students agreed that it is more difficult for women to balance a career and family in engineering compared to other career fields.

Ranking	Female Students	Male Students
1	Getting help with engineering modules	Getting help with engineering modules
2	Getting advice or mentoring about engineering	Helping others
3	Talking about issues of concern in engineering	Talking about issues of concern in engineering
4	Socialising with other women in engineering	Learning about a topic of interest related to engineering
5	Being in a supportive atmosphere	Getting advice or mentoring about engineering

Table 4.9: Top five reasons for participation in a study or support group.

Table 4.9 above indicates the top five reasons for female students and the top five reasons for male students for participation in a study or support group. Both genders indicated that the top reason for participating in a study or support group is to get help with engineering modules. When observing the other reasons, there are some similarities between the two genders. The findings clearly indicate that there is no difference between genders regarding their reasons for participating in a study or support group.

The following sub-section will elaborate on the findings for Section 5 – Faculty Related Questions.

4.3.2.8. Section 5 – Faculty Related Questions

Section 5 – Faculty Related Questions, data were captured regarding the Faculty of Engineering and the perceptions the students have towards the faculty. Figures 4.61 – 4.75 depict both female and male students' perception on faculty related questions, including the support they receive from the faculty. The findings will be elaborated below.

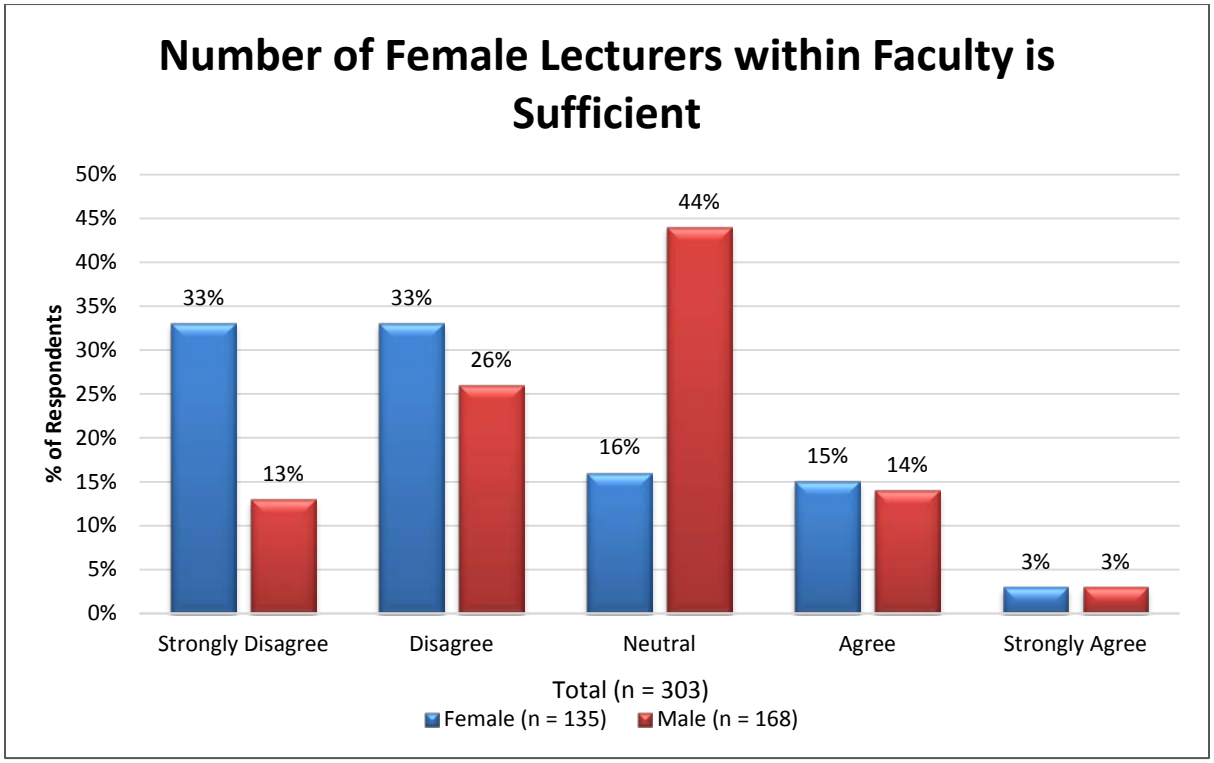

Figure 4.61: Number of female lecturers within faculty is sufficient.

Figure 4.61 depicts the total responses (n = 303) received from the female responses (n = 135) and male responses (n = 168) for their opinion whether the 'number of female lecturers within the faculty is sufficient'. Thirty-three percent (n = 44) of the female respondents indicated **'Strongly Disagree'** and 13 percent (n = 21) of the male respondents indicated **'Strongly Disagree'**. Thirty-three percent (n = 44) of the female respondents indicated **'Disagree'** and 26 percent (n = 44) of the male respondents indicated **'Disagree'**. Sixteen percent (n = 22) of the female respondents indicated **'Neutral'** and 44 percent (n = 74) of the male respondents indicated **'Neutral'**. Fifteen percent (n = 21) of the female respondents indicated **'Agree'** and 14 percent (n = 24) of the male respondents indicated **'Agree'**. Three percent (n = 4) of the female respondents indicated **'Strongly Agree'** and 3 percent (n = 5) of the male respondents indicated **'Strongly Agree'**.

The findings indicate that the majority of female students strongly disagree that the number of female lecturers within the faculty is sufficient and the majority of male students indicated neutral for this statement. The high response rate on 'Neutral' from the male students could be that they are unsure regarding this statement. However, the minority of both female and male students strongly agree with this statement. As mentioned before, it is important for female students to be in the presence of female academic staff, at a higher education institution. They serve as role models and mentors for female undergraduate and

postgraduate students. This will lead to a critical role that the leaders of the engineering departments and university management play, in order to support the importance of attracting and retaining female students (Mills, 2011).

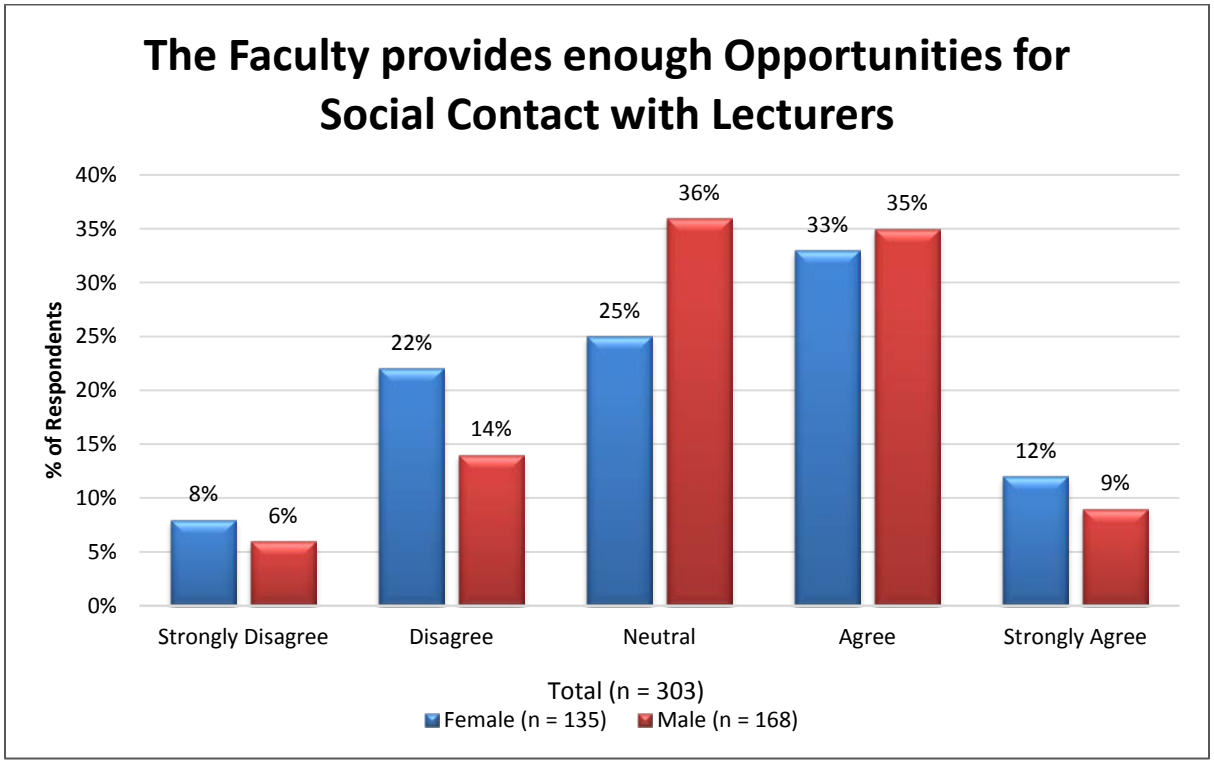

Figure 4.62: The Faculty provides enough opportunities for social contact with lecturers.

Figure 4.62 depicts the total responses (n = 303) received from the female responses (n = 135) and male responses (n = 168) for their opinion whether 'the faculty provides enough opportunities for social contact with lecturers'. Eight percent (n = 11) of the female respondents indicated **'Strongly Disagree'** and 6 percent (n = 10) of the male respondents indicated **'Strongly Disagree'**. Twenty-two percent (n = 29) of the female respondents indicated **'Disagree'** and 14 percent (n = 24) of the male respondents indicated **'Disagree'**. Twenty-five percent (n = 34) of the female respondents indicated **'Neutral'** and 36 percent (n = 61) of the male respondents indicated **'Neutral'**. Thirty-three percent (n = 45) of the female respondents indicated **'Agree'** and 35 percent (n = 58) of the male respondents indicated **'Agree'**. Twelve percent (n = 16) of the female respondents indicated **'Strongly Agree'** and 9 percent (n = 15) of the male respondents indicated **'Strongly Agree'**.

The findings indicate that the majority of female students agree that the faculty provides enough opportunities for social contact with lecturers and the majority of male students are neutral with this statement. The high response rate on 'Neutral' from the male students

could be to avoid negative feelings associated with their conflicting feelings towards this statement or they are unsure regarding this statement. However, the minority of both female and male students strongly disagree with this statement.

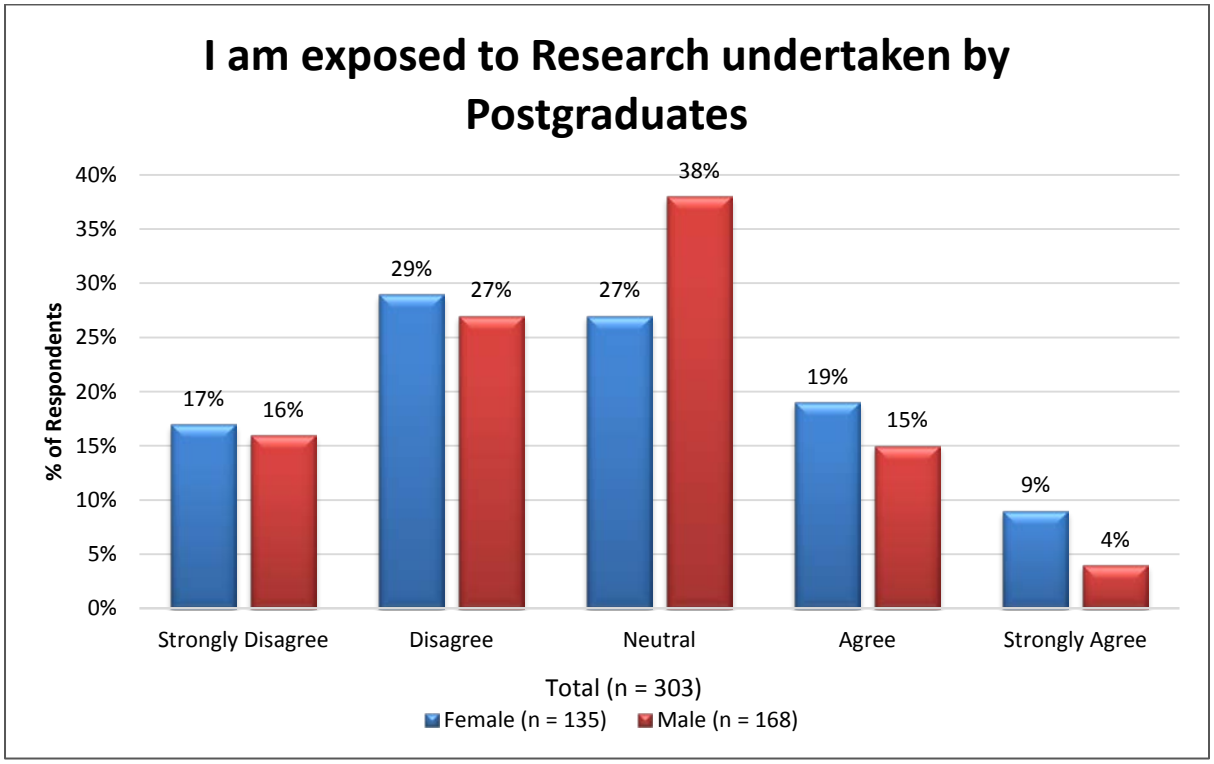

Figure 4.63: I am exposed to the research undertaken by postgraduates.

Figure 4.63 depicts the total responses (n = 303) received from the female responses (n = 135) and male responses (n = 168) for their opinion whether 'I am exposed to research undertaken by postgraduates'. Seventeen percent (n = 23) of the female respondents indicated **'Strongly Disagree'** and 16 percent (n = 26) of the male respondents indicated **'Strongly Disagree'**. Twenty-nine percent (n = 39) of the female respondents indicated **'Disagree'** and 27 percent (n = 47) of the male respondents indicated **'Disagree'**. Twenty-seven percent (n = 36) of the female respondents indicated **'Neutral'** and 38 percent (n = 63) of the male respondents indicated **'Neutral'**. Nineteen percent (n = 25) of the female respondents indicated **'Agree'** and 15 percent (n = 25) of the male respondents indicated **'Agree'**. Nine percent (n = 12) of the female respondents indicated **'Strongly Agree'** and 4 percent (n = 7) of the male respondents indicated **'Strongly Agree'**.

The findings indicate that the majority of female students disagree that they are exposed to research undertaken by postgraduates and the majority of male students indicated neutral on this statement. However, the minority of both female and male students strongly agree

with this statement. The high response rate on 'Neutral' from both genders could be that they are unsure regarding this statement.

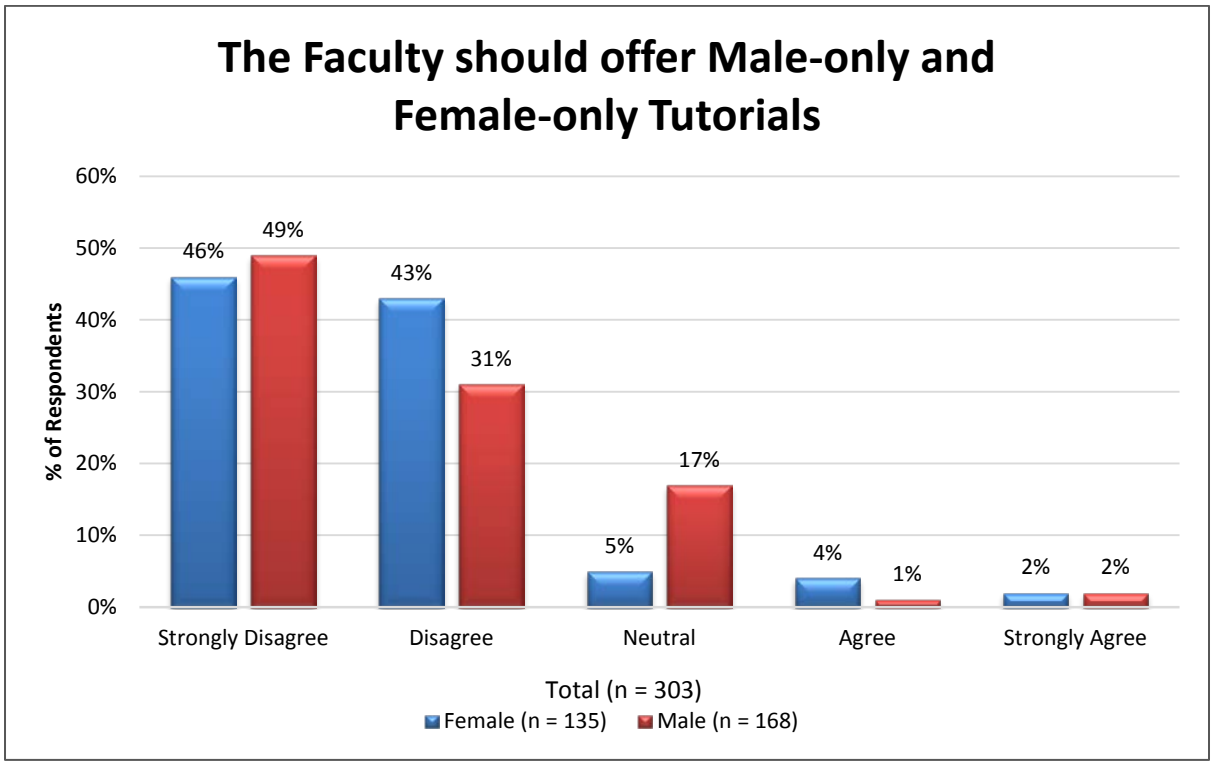

Figure 4.64: The faculty should offer male-only and female-only tutorials.

Figure 4.64 depicts the total responses (n = 303) received from the female responses (n = 135) and male responses (n = 168) for their opinion whether the 'faculty should offer male-only and female-only tutorials'. Forty-six percent (n = 62) of the female respondents indicated **'Strongly Disagree'** and 49 percent (n = 83) of the male respondents indicated **'Strongly Disagree'**. Forty-three percent (n = 58) of the female respondents indicated **'Disagree'** and 31 percent (n = 52) of the male respondents indicated **'Disagree'**. Five percent (n = 7) of the female respondents indicated **'Neutral'** and 17 percent (n = 29) of the male respondents indicated **'Neutral'**. Four percent (n = 5) of the female respondents indicated **'Agree'** and 1 percent (n = 1) of the male respondents indicated **'Agree'**. Two percent (n = 3) of the female respondents indicated **'Strongly Agree'** and 2 percent (n = 3) of the male respondents indicated **'Strongly Agree'**.

The findings indicate that the majority of both female and male students strongly disagree that the faculty should offer male-only and female-only tutorials. However, the minority of female students strongly agree with this statement and the minority of male students agree with this statement. Therefore, it is aligned with the research in chapter 2 stating that female

and male students receive the same quality training, which includes the knowledge, skills and experience. Therefore, females are consequently equally equipped as their male counterparts (Perez, 2011).

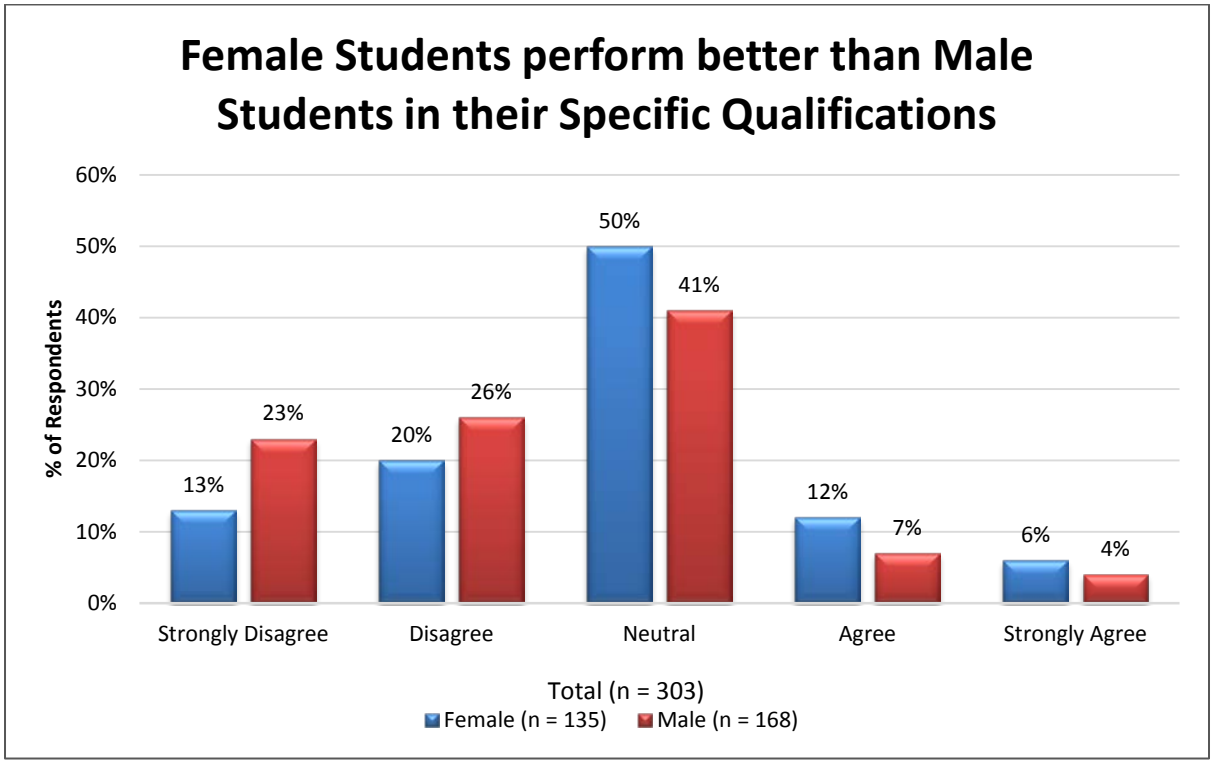

Figure 4.65: Female students perform better than male students in their specific qualifications.

Figure 4.65 depicts the total responses (n = 303) received from the female responses (n = 135) and male responses (n = 168) for their opinion whether 'female student perform better than male students in their specific qualifications'. Thirteen percent (n = 17) of the female respondents indicated **'Strongly Disagree'** and 23 percent (n = 38) of the male respondents indicated **'Strongly Disagree'**. Twenty percent (n = 27) of the female respondents indicated **'Disagree'** and 26 percent (n = 44) of the male respondents indicated **'Disagree'**. Fifty percent (n = 67) of the female respondents indicated **'Neutral'** and 41 percent (n = 69) of the male respondents indicated **'Neutral'**. Twelve percent (n = 16) of the female respondents indicated **'Agree'** and 7 percent (n = 11) of the male respondents indicated **'Agree'**. Six percent (n = 8) of the female respondents indicated **'Strongly Agree'** and 4 percent (n = 6) of the male respondents indicated **'Strongly Agree'**.

The findings indicate that the majority of both female and male students indicated neutral that female students perform better than male students in their specific qualifications. The

high response rate on 'Neutral' from both genders could be to avoid negative feelings associated with their conflicting feelings towards this statement or they are unsure regarding this statement. However, the minority of both female and male students strongly agree with this statement.

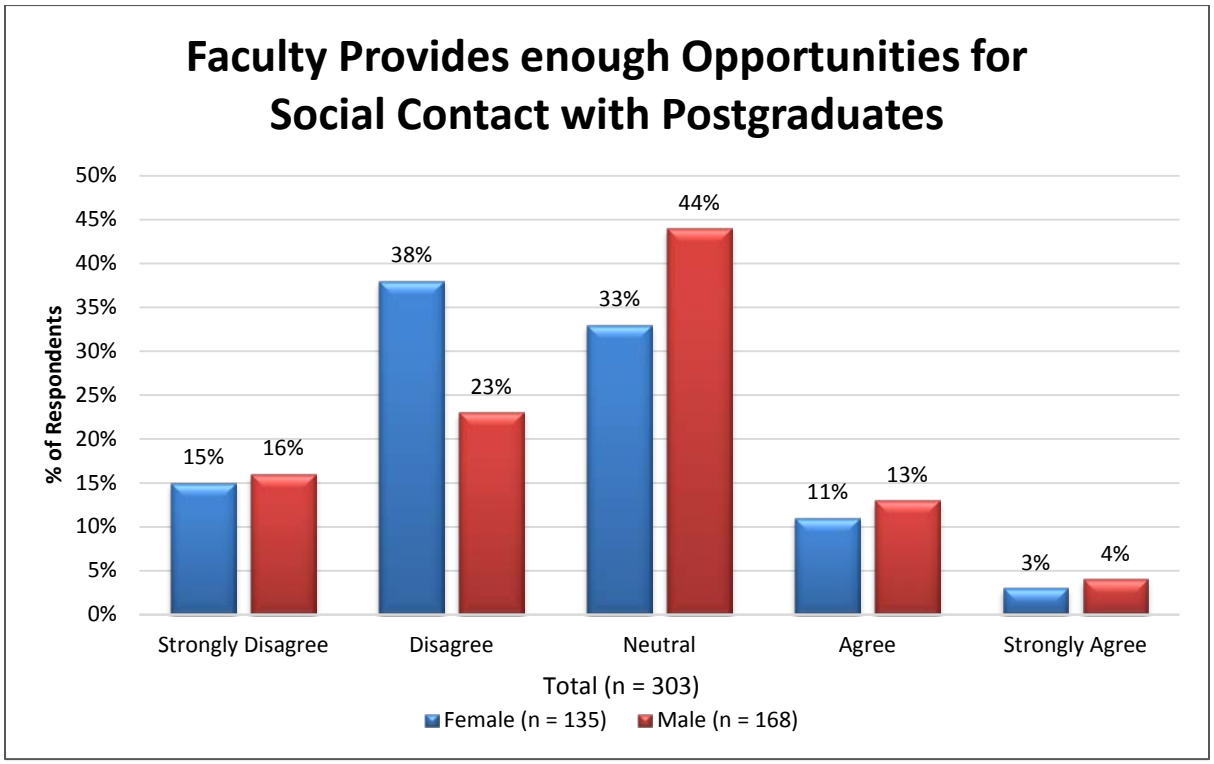

Figure 4.66: Faculty provides enough opportunities for social contact with postgraduates.

Figure 4.66 depicts the total responses (n = 303) received from the female responses (n = 135) and male responses (n = 168) for their opinion whether the 'faculty provides enough opportunities for social contact with postgraduates'. Fifteen percent (n = 21) of the female respondents indicated **'Strongly Disagree'** and 16 percent (n = 26) of the male respondents indicated **'Strongly Disagree'**. Thirty-eight percent (n = 51) of the female respondents indicated **'Disagree'** and 23 percent (n = 40) of the male respondents indicated **'Disagree'**. Thirty-three percent (n = 44) of the female respondents indicated **'Neutral'** and 44 percent (n = 75) of the male respondents indicated **'Neutral'**. Eleven percent (n = 15) of the female respondents indicated **'Agree'** and 13 percent (n = 21) of the male respondents indicated **'Agree'**. Three percent (n = 4) of the female respondents indicated **'Strongly Agree'** and 4 percent (n = 6) of the male respondents indicated **'Strongly Agree'**.

The findings indicate that the majority of female students disagree that the faculty provides enough opportunities for social contact with postgraduates and the majority of male students

indicated neutral on this statement. The high response rate on 'Neutral' from both genders could be to avoid negative feelings associated with their conflicting feelings towards this statement or they are unsure regarding this statement. However, the minority of both female and male students strongly agree with this statement.

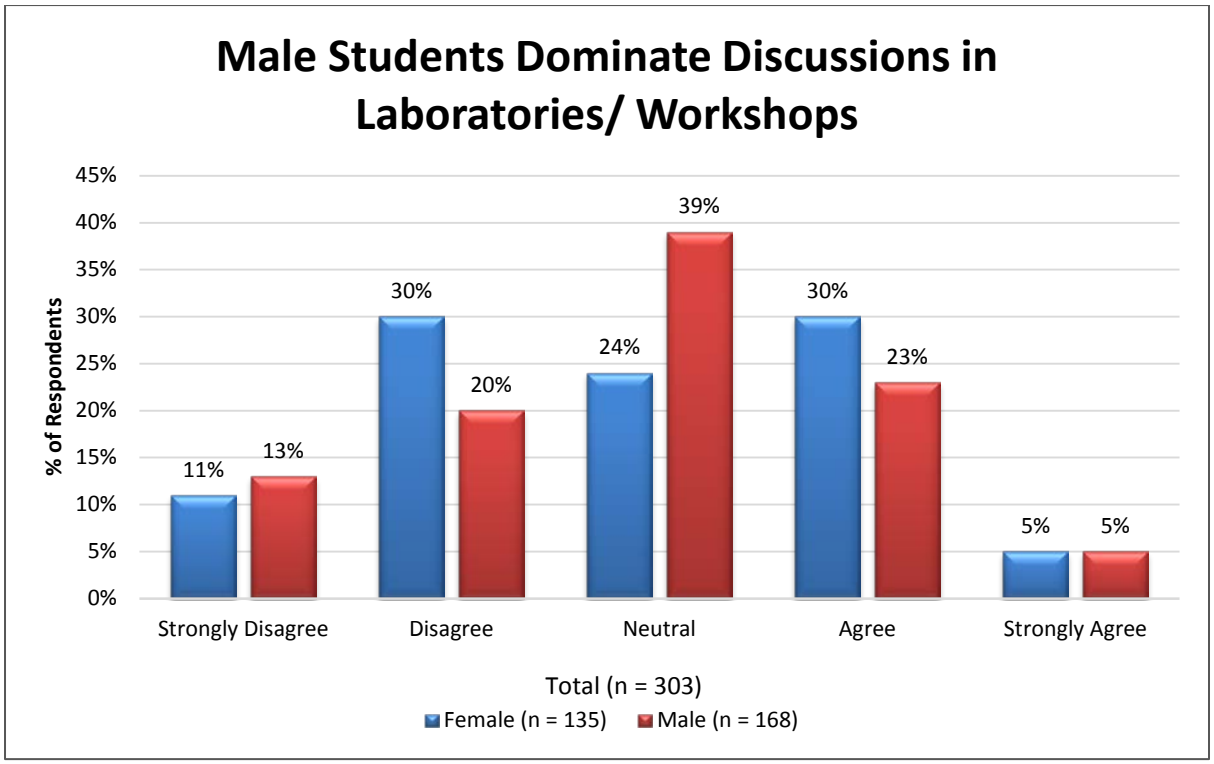

Figure 4.67: Male students dominate discussions in laboratories/workshops.

Figure 4.67 depicts the total responses (n = 303) received from the female responses (n = 135) and male responses (n = 168) for their opinion whether 'male students dominate discussions in laboratories/ workshops'. Eleven percent (n = 15) of the female respondents indicated **'Strongly Disagree'** and 13 percent (n = 22) of the male respondents indicated **'Strongly Disagree'**. Thirty percent (n = 41) of the female respondents indicated **'Disagree'** and 20 percent (n = 34) of the male respondents indicated **'Disagree'**. Twenty-four percent (n = 32) of the female respondents indicated **'Neutral'** and 23 percent (n = 39) of the male respondents indicated **'Neutral'**. Thirty percent (n = 40) of the female respondents indicated **'Agree'** and 23 percent (n = 39) of the male respondents indicated **'Agree'**. Five percent (n = 7) of the female respondents indicated **'Strongly Agree'** and 5 percent (n = 8) of the male respondents indicated **'Strongly Agree'**.

The findings indicate that the majority of female students disagree that male students dominate discussions in laboratories/workshops and the majority of male students indicated

neutral on this statement. The high response rate on 'Neutral' from the male students could be to avoid negative feelings associated with their conflicting feelings towards this statement or they are unsure regarding this statement. However, the minority of both female and male students strongly agree with this statement.

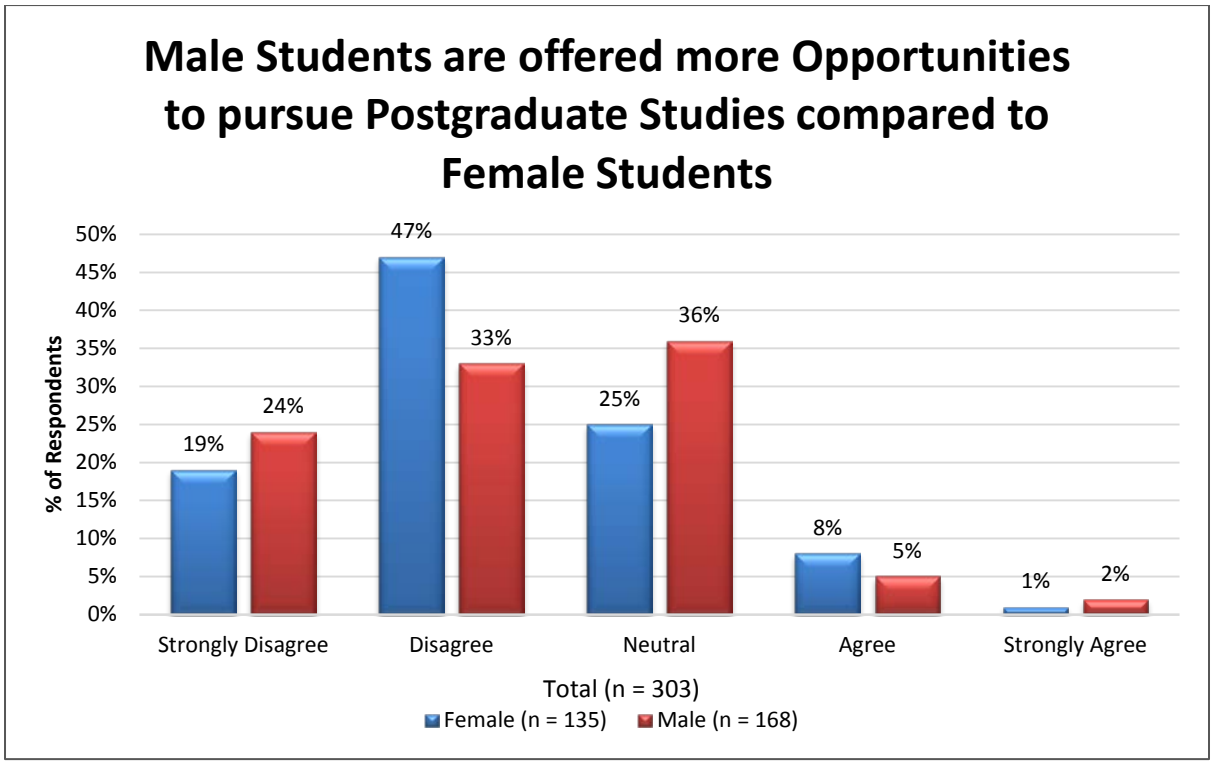

Figure 4.68: Male students are offered more opportunities to pursue postgraduate studies compared to female students.

Figure 4.68 depicts the total responses (n = 303) received from the female responses (n = 135) and male responses (n = 168) for their opinion whether 'male students are offered more opportunities to pursue postgraduate studies compared to female students'. Nineteen percent (n = 25) of the female respondents indicated **'Strongly Disagree'** and 24 percent (n = 41) of the male respondents indicated **'Strongly Disagree'**. Forty-seven percent (n = 64) of the female respondents indicated **'Disagree'** and 33 percent (n = 55) of the male respondents indicated **'Disagree'**. Twenty-five percent (n = 34) of the female respondents indicated **'Neutral'** and 36 percent (n = 60) of the male respondents indicated **'Neutral'**. Eight percent (n = 11) of the female respondents indicated **'Agree'** and 5 percent (n = 9) of the male respondents indicated **'Agree'**. One percent (n = 1) of the female respondents indicated **'Strongly Agree'** and 2 percent (n = 3) of the male respondents indicated **'Strongly Agree'**.

The findings indicate that the majority of female students disagree that male students are offered more opportunities to pursue postgraduate studies compared to female students and the majority of male students indicated neutral on this statement. However, the minority of both female and male students strongly agree with this statement. Generally, women are more qualified than men, but they are still earning less. However, women are more likely to further their studies to post graduate degrees then men (Chamie, 2014).

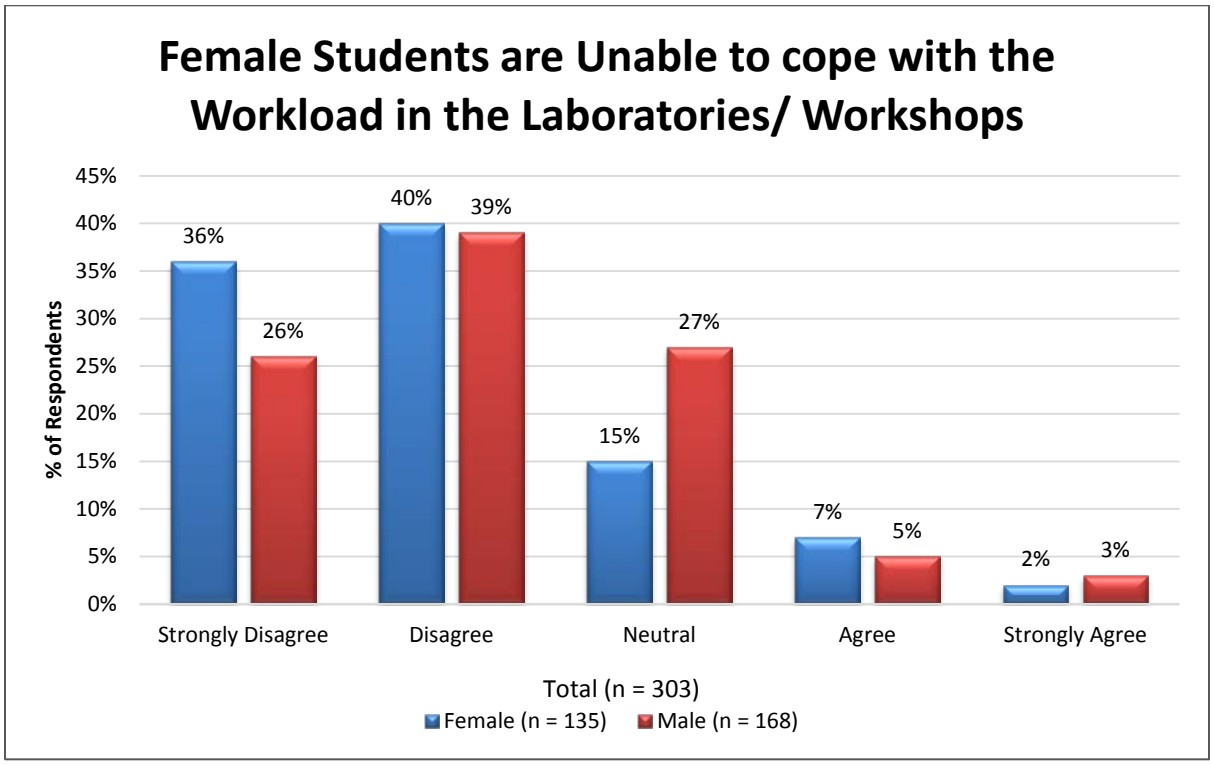

Figure 4.69: Female students are unable to cope with the workload in the laboratories/ workshops.

Figure 4.69 depicts the total responses (n = 303) received from the female responses (n = 135) and male responses (n = 168) for their opinion whether 'female students are unable to cope with the workload in the laboratories or workshops'. Thirty-six percent (n = 49) of the female respondents indicated **'Strongly Disagree'** and 26 percent (n = 43) of the male respondents indicated **'Strongly Disagree'**. Forty percent (n = 54) of the female respondents indicated **'Disagree'** and 39 percent (n = 66) of the male respondents indicated **'Disagree'**. Fifteen percent (n = 20) of the female respondents indicated **'Neutral'** and 27 percent (n = 46) of the male respondents indicated **'Neutral'**. Seven percent (n = 10) of the female respondents indicated **'Agree'** and 5 percent (n = 8) of the male respondents indicated **'Agree'**. Two percent (n = 2) of the female respondents indicated **'Strongly Agree'** and 3 percent (n = 5) of the male respondents indicated **'Strongly Agree'**.

The findings indicate that the majority of both female and male students disagree that female students are unable to cope with the workload in the laboratories or workshops. However, the minority of both female and male students strongly agree with this statement. As mentioned before, female and male students receive the same quality training, which includes the knowledge, skills and experience. Therefore, females are consequently equally equipped as their males counterparts (Perez, 2011).

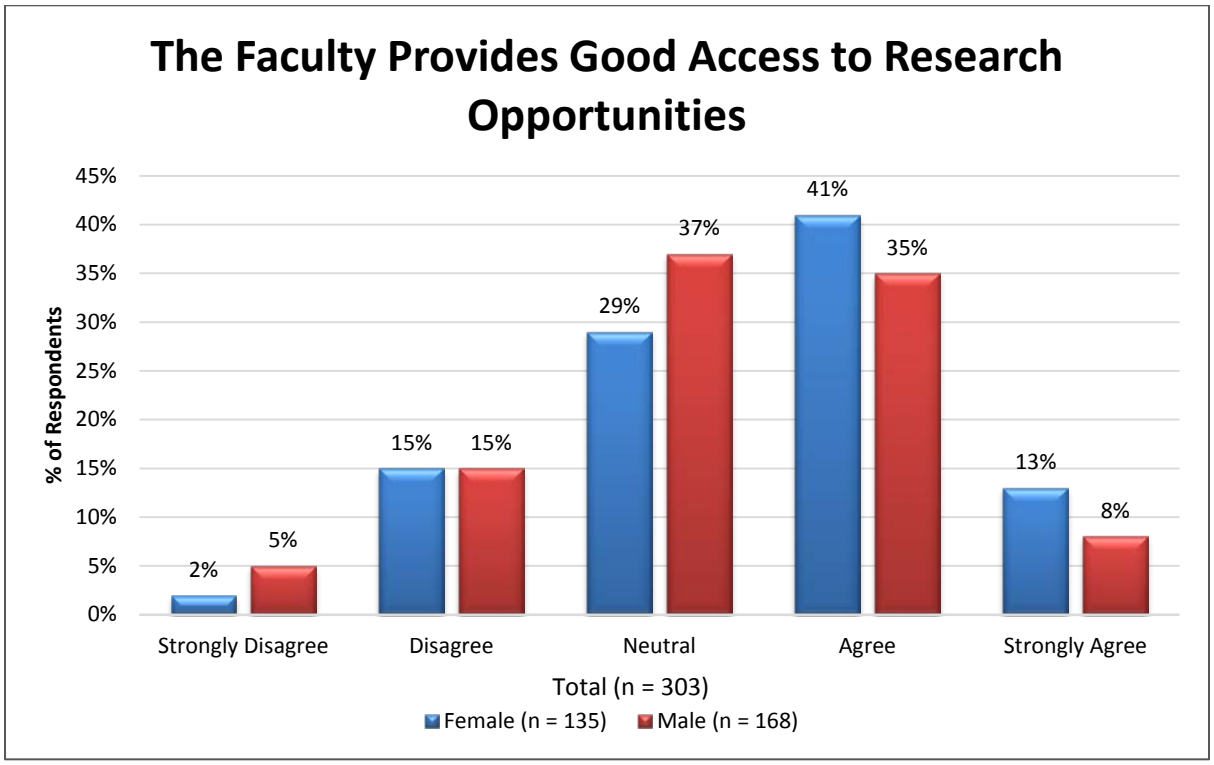

Figure 4.70: The Faculty provides good access to research opportunities.

Figure 4.70 depicts the total responses (n = 303) received from the female responses (n = 135) and male responses (n = 168) for their opinion whether 'the faculty provides good access to research opportunities'. Two percent (n = 3) of the female respondents indicated **'Strongly Disagree'** and 5 percent (n = 8) of the male respondents indicated **'Strongly Disagree'**. Fifteen percent (n = 20) of the female respondents indicated **'Disagree'** and 15 percent (n = 25) of the male respondents indicated **'Disagree'**. Twenty-nine percent (n = 39) of the female respondents indicated **'Neutral'** and 37 percent (n = 62) of the male respondents indicated **'Neutral'**. Forty-one percent (n = 55) of the female respondents indicated **'Agree'** and 35 percent (n = 60) of the male respondents indicated **'Agree'**. Thirteen percent (n = 18) of the female respondents indicated **'Strongly Agree'** and 8 percent (n = 13) of the male respondents indicated **'Strongly Agree'**.

The findings indicate that the majority of female students agree that the faculty provides good access to research opportunities and the majority of male students indicated neutral on this statement. The high response rate on 'Neutral' from both genders could be that they are unsure regarding this statement. However, the minority of both female and male students strongly disagree with this statement.

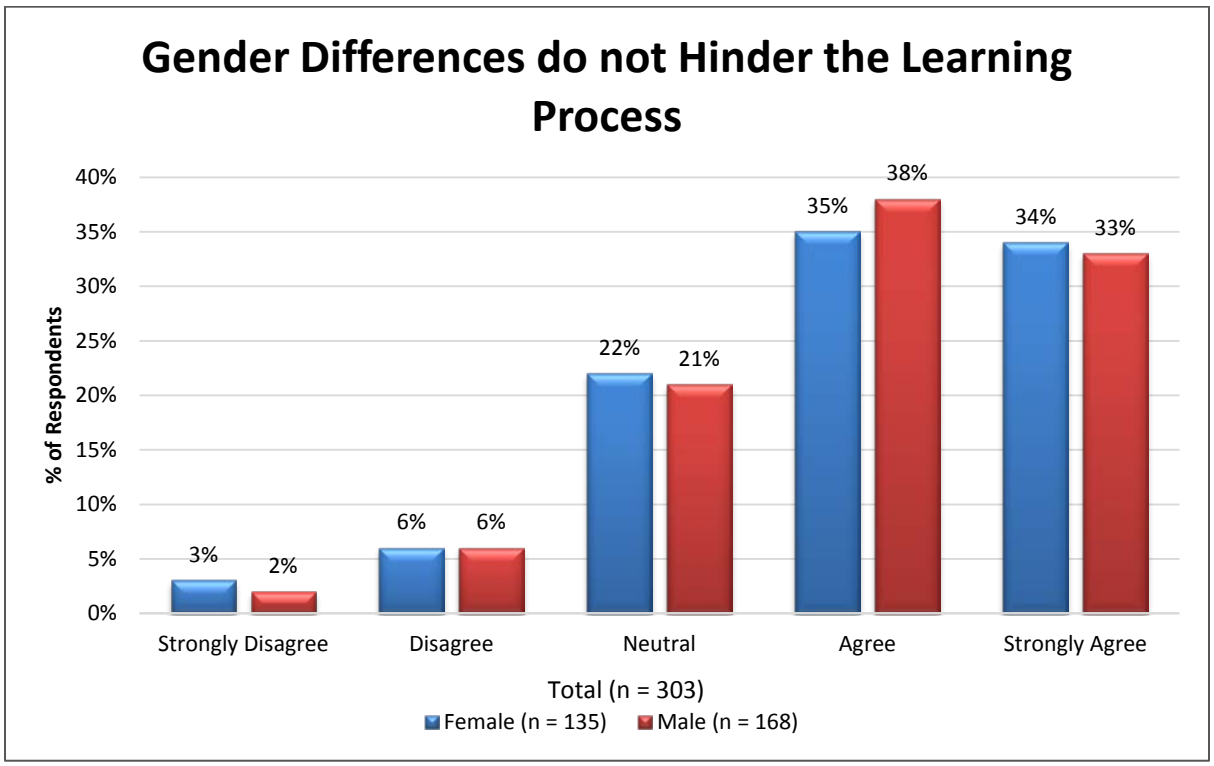

Figure 4.71: Gender differences do not hinder the learning process.

Figure 4.71 depicts the total responses (n = 303) received from the female responses (n = 135) and male responses (n = 168) for their opinion whether 'gender differences do not hinder the learning process'. Three percent (n = 4) of the female respondents indicated **'Strongly Disagree'** and 2 percent (n = 3) of the male respondents indicated **'Strongly Disagree'**. Six percent (n = 8) of the female respondents indicated **'Disagree'** and 6 percent (n = 10) of the male respondents indicated **'Disagree'**. Twenty-two percent (n = 30) of the female respondents indicated **'Neutral'** and 38 percent (n = 64) of the male respondents indicated **'Neutral'**. Thirty-five percent (n = 47) of the female respondents indicated **'Agree'** and 38 percent (n = 64) of the male respondents indicated **'Agree'**. Thirty-four percent (n = 46) of the female respondents indicated **'Strongly Agree'** and 33 percent (n = 56) of the male respondents indicated **'Strongly Agree'**.

The findings indicate that the majority of both female and male students agree that gender differences do not hinder the learning process. However, the minority of both female and male students strongly disagree with this statement.

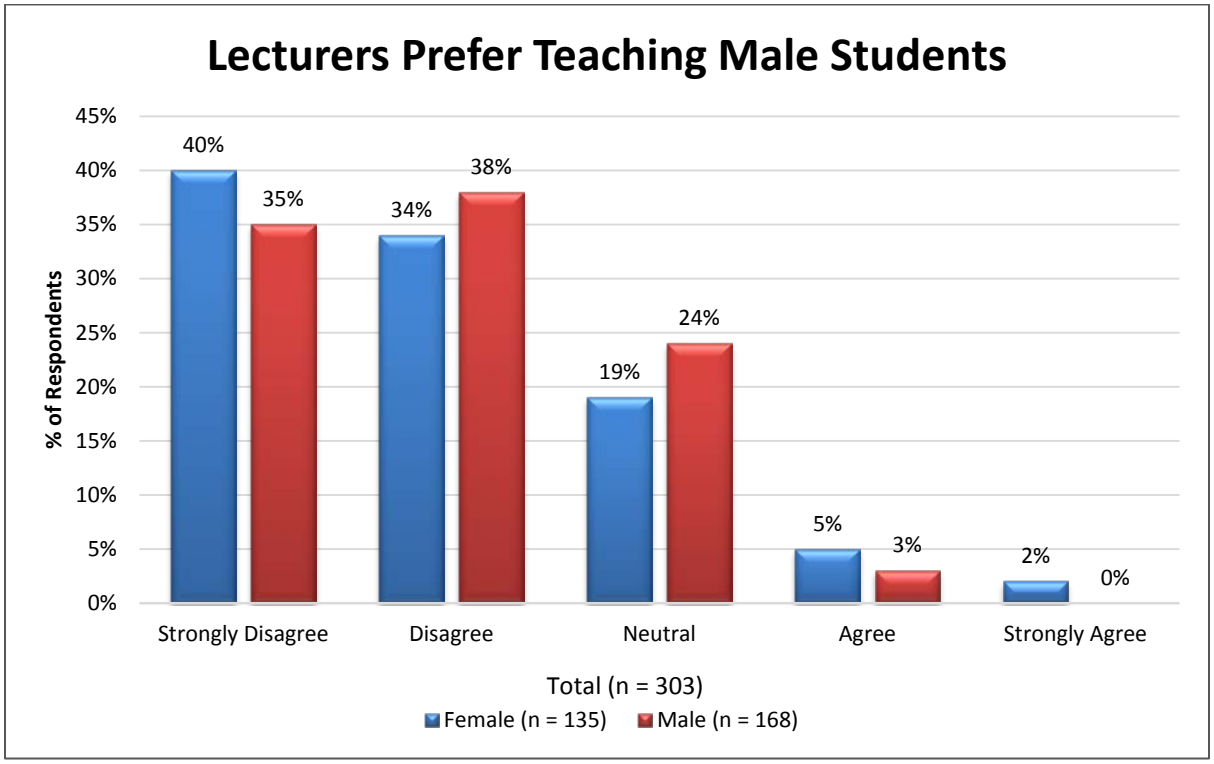

Figure 4.72: Lecturers prefer teaching male students.

Figure 4.72 depicts the total responses (n = 303) received from the female responses (n = 135) and male responses (n = 168) for their opinion whether 'lecturers prefer teaching male students'. Forty percent (n = 54) of the female respondents indicated **'Strongly Disagree'** and 35 percent (n = 59) of the male respondents indicated **'Strongly Disagree'**. Thirty-four percent (n = 46) of the female respondents indicated **'Disagree'** and 38 percent (n = 63) of the male respondents indicated **'Disagree'**. Nineteen percent (n = 25) of the female respondents indicated **'Neutral'** and 24 percent (n = 41) of the male respondents indicated **'Neutral'**. Five percent (n = 7) of the female respondents indicated **'Agree'** and 5 percent (n = 3) of the male respondents indicated **'Agree'**. Three percent (n = 2) of the female respondents indicated **'Strongly Agree'** and none of the male respondents indicated **'Strongly Agree'**.

The findings indicate that the majority of female students strongly disagree that lecturers prefer teaching male students and the majority of male students disagree with this

statement. However, the minority of both female and male students strongly agree with this statement.

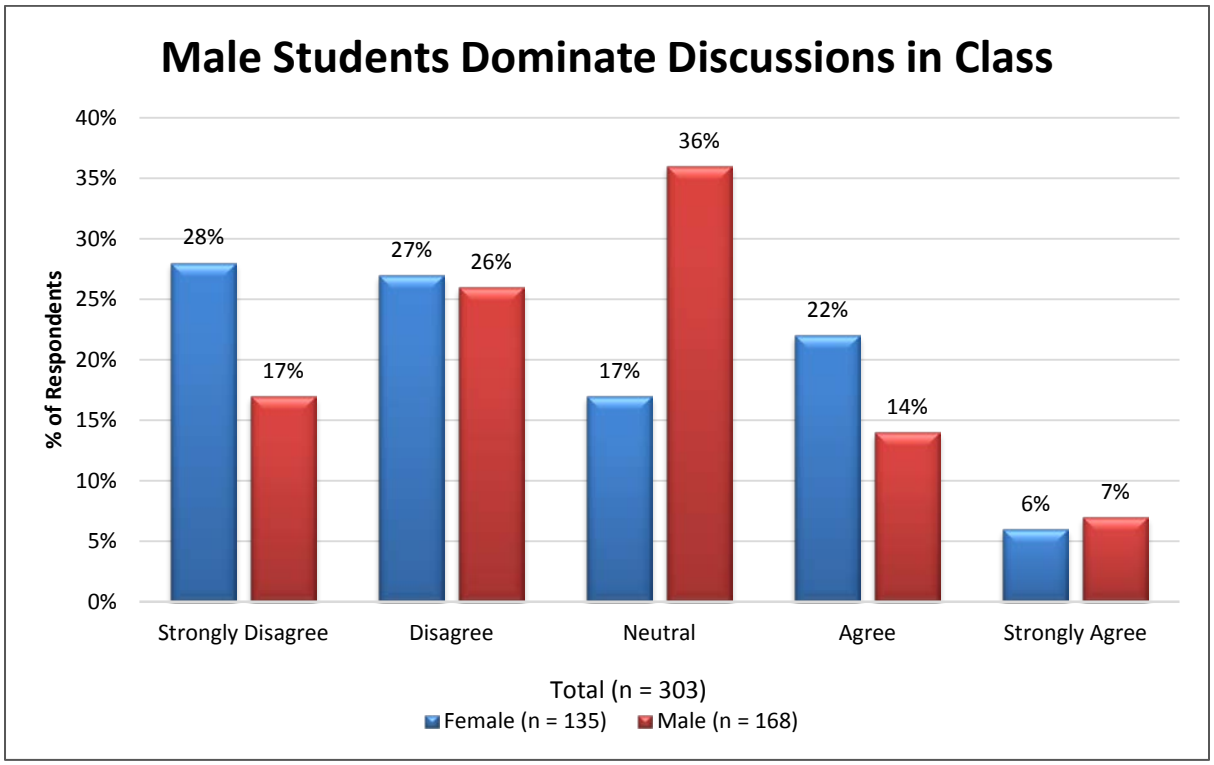

Figure 4.73: Male students dominate discussions in class.

Figure 4.73 depicts the total responses (n = 303) received from the female responses (n = 135) and male responses (n = 168) for their opinion whether 'male students dominated discussions in class'. Twenty-eight percent (n = 38) of the female respondents indicated **'Strongly Disagree'** and 17 percent (n = 29) of the male respondents indicated **'Strongly Disagree'**. Twenty-seven percent (n = 36) of the female respondents indicated **'Disagree'** and 26 percent (n = 43) of the male respondents indicated **'Disagree'**. Seventeen percent (n = 23) of the female respondents indicated **'Neutral'** and 36 percent (n = 61) of the male respondents indicated **'Neutral'**. Twenty-two percent (n = 30) of the female respondents indicated **'Agree'** and 14 percent (n = 24) of the male respondents indicated **'Agree'**. Six percent (n = 8) of the female respondents indicated **'Strongly Agree'** and 7 percent (n = 11) of the male respondents indicated **'Strongly Agree'**.

The findings indicate that the majority of female students strongly disagree that male students dominate discussions in class and the majority of male students indicated neutral to this statement. However, the minority of both female and male students strongly agree with this statement.

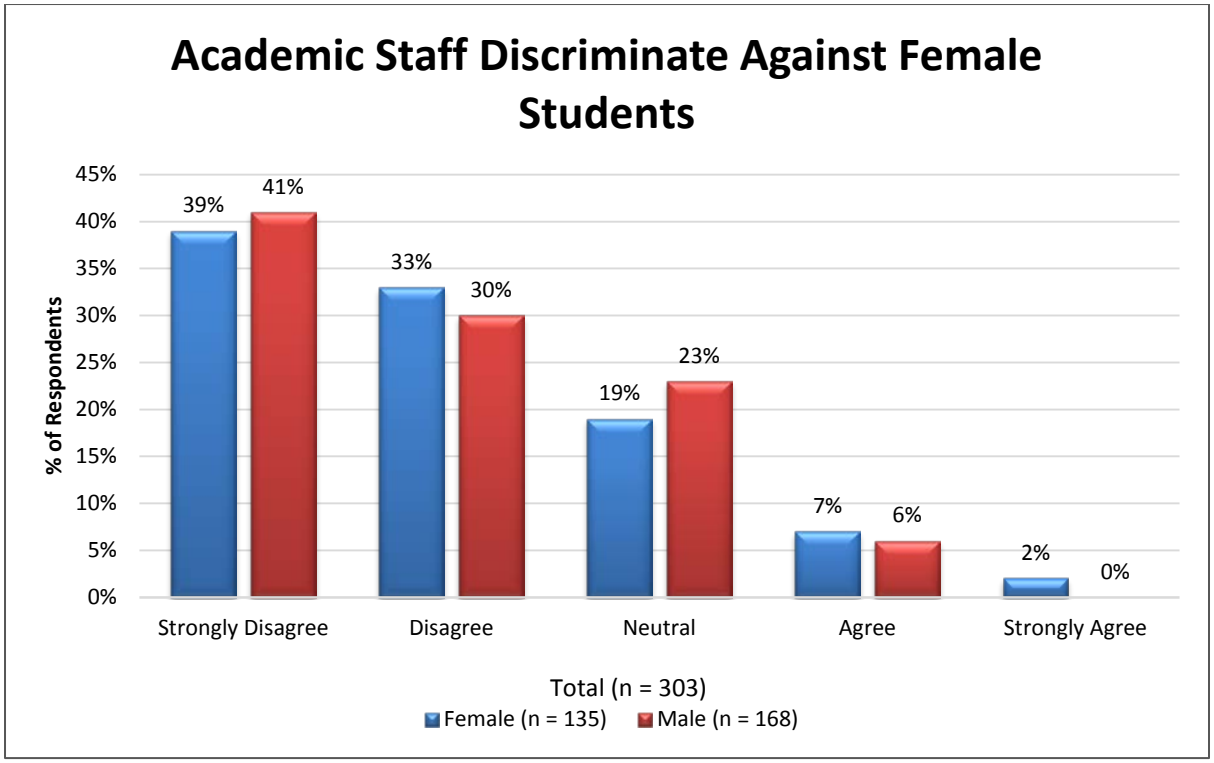

Figure 4.74: Academic staff discriminate against female students.

Figure 4.74 depicts the total responses (n = 303) received from the female responses (n = 135) and male responses (n = 168) for their opinion whether 'academic staff discriminates against female students'. Thirty-nine percent (n = 53) of the female respondents indicated **'Strongly Disagree'** and 41 percent (n = 69) of the male respondents indicated **'Strongly Disagree'**. Thirty-three percent (n = 44) of the female respondents indicated **'Disagree'** and 30 percent (n = 51) of the male respondents indicated **'Disagree'**. Nineteen percent (n = 25) of the female respondents indicated **'Neutral'** and 23 percent (n = 38) of the male respondents indicated **'Neutral'**. Seven percent (n = 10) of the female respondents indicated **'Agree'** and 6 percent (n = 10) of the male respondents indicated **'Agree'**. Two percent (n = 3) of the female respondents indicated **'Strongly Agree'** and none of the male respondents indicated **'Strongly Agree'**.

The findings indicate that the majority of both female and male students strongly disagree that academic staff discriminate against female students. However, the minority of both female and male students strongly agree with this statement.

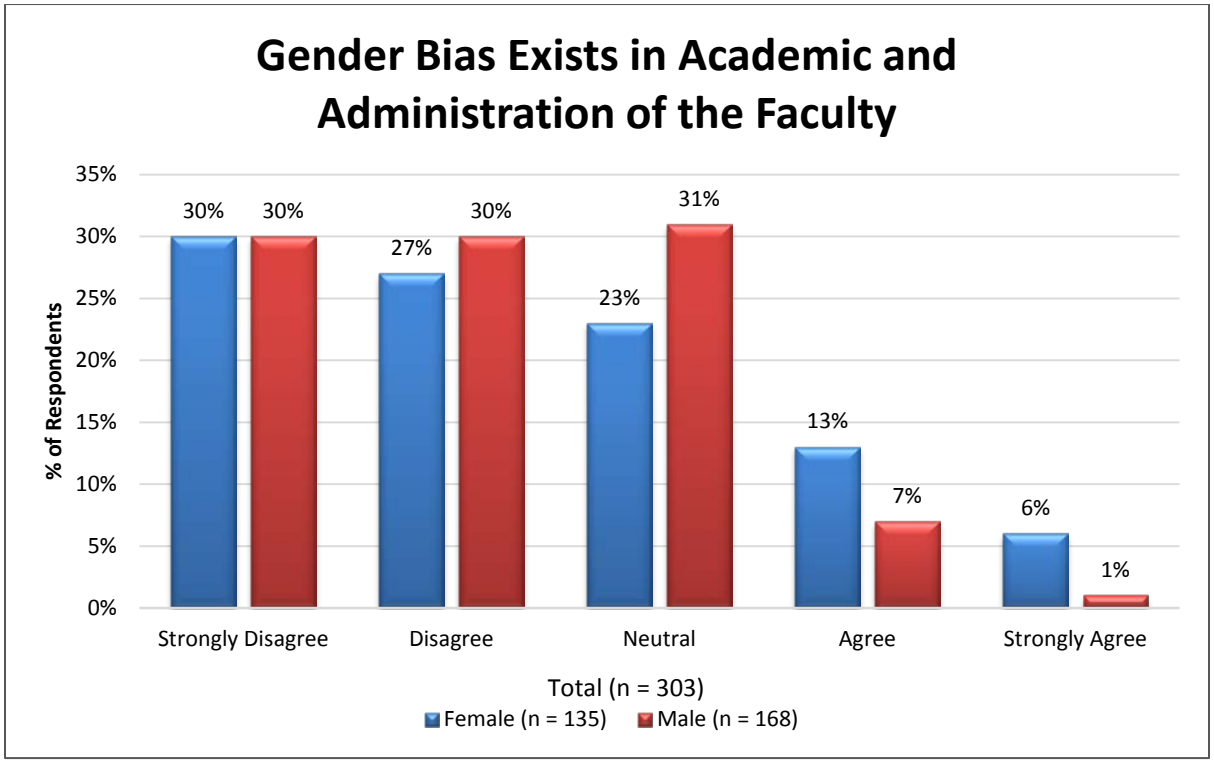

Figure 4.75: Gender bias exists in the academic and administration of the faculty.

Figure 4.75 depicts the total responses (n = 303) received from the female responses (n = 135) and male responses (n = 168) for their opinion whether 'gender bias exists in the academic and administration of the faculty'. Thirty percent (n = 41) of the female respondents indicated **'Strongly Disagree'** and 30 percent (n = 51) of the male respondents indicated **'Strongly Disagree'**. Twenty-seven percent (n = 37) of the female respondents indicated **'Disagree'** and 30 percent (n = 51) of the male respondents indicated **'Disagree'**. Twenty-three percent (n = 31) of the female respondents indicated **'Neutral'** and 31 percent (n = 52) of the male respondents indicated **'Neutral'**. Thirteen percent (n = 18) of the female respondents indicated **'Agree'** and 7 percent (n = 12) of the male respondents indicated **'Agree'**. Six percent (n = 8) of the female respondents indicated **'Strongly Agree'** and 1 percent (n = 2) of the male respondents indicated **'Strongly Agree'**.

The findings indicate that the majority of female students strongly disagree that gender bias exists in the academic and administration of the faculty and the majority of male students indicated neutral to this statement. The high response rate on 'Neutral' from both genders could be to avoid negative feelings associated with their conflicting feelings towards this statement or they are unsure regarding this statement. However, the minority of both female and male students strongly agree with this statement. However, as soon as females enter the university environment, they are already at a disadvantage due to gender inequality

(Stonyer, 2002). There are clear gender differences in certain career fields, for example men are dominate in the field of science, computing and engineering and women dominate in the field of education and health (OECD, 2015).

Variable	T-tests; Grouping: Gender								
	Mean (1)	Mean (2)	t-value	df	p	Valid N (1)	Valid N (2)	Std Dev. (1)	Std Dev. (2)
Support	2.57	2.58	0.2774	301	0.78169	135	168	0.41457	0.45579

Table 4.10: T-tests on Gender with Support variables.

Table 4.10 indicates a t-test conducted on gender regarding their experience regarding the support they receive from the faculty. $p > 0.05$ which indicates that no significant difference between gender exists with regards to support from the faculty. The mean for both female and male students are three, indicating that the average for both genders indicated 'neutral' on the above variables. The Cronbach Alpha for this construct was established as 0.68 indicating minimally acceptable reliability.

Figures 4.76 – 4.84 depicts both female and male students' perception on their experience regarding the university's feedback. The findings will be elaborated below.

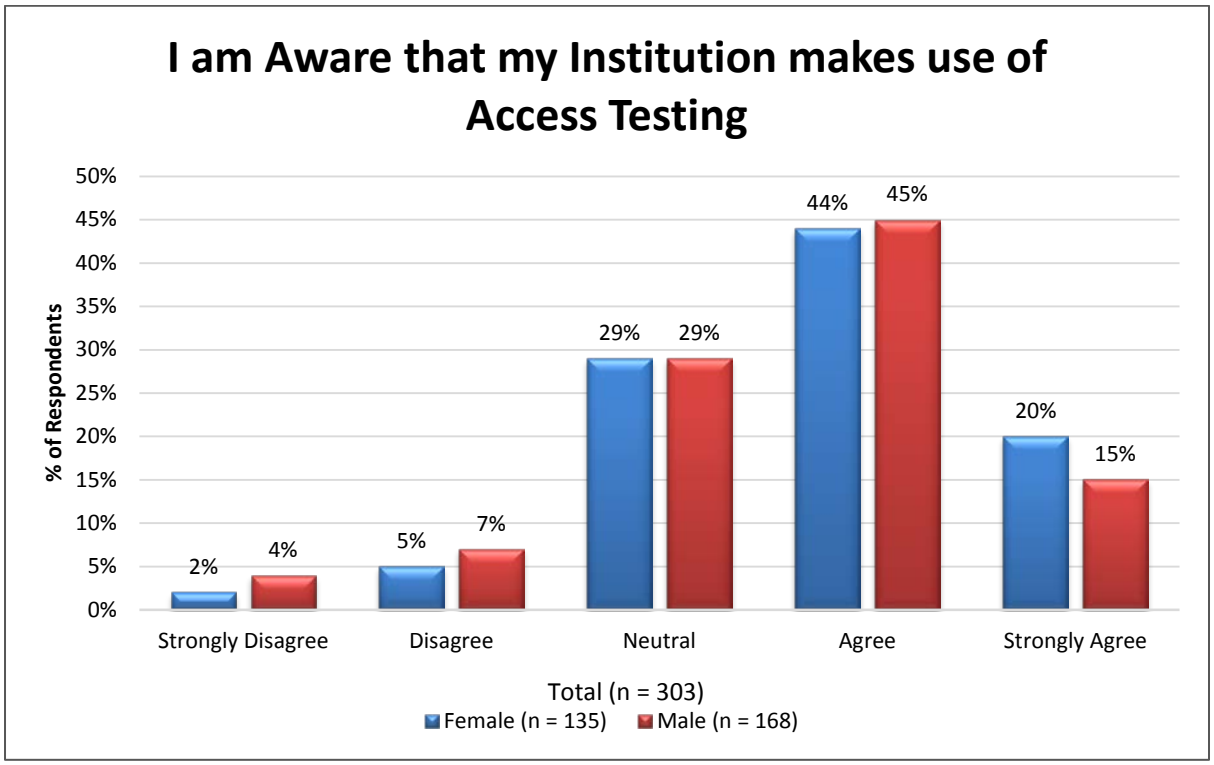

Figure 4.76: I am aware that my institution makes use of access testing.

Figure 4.76 depicts the total responses (n = 303) received from the female responses (n = 135) and male responses (n = 168) for their opinion whether 'I am aware that my institution makes use of access testing'. Two percent (n = 3) of the female respondents indicated **'Strongly Disagree'** and 4 percent (n = 7) of the male respondents indicated **'Strongly Disagree'**. Five percent (n = 7) of the female respondents indicated **'Disagree'** and 7 percent (n = 11) of the male respondents indicated **'Disagree'**. Twenty-nine percent (n = 39) of the female respondents indicated **'Neutral'** and 29 percent (n = 48) of the male respondents indicated **'Neutral'**. Forty-four percent (n = 59) of the female respondents indicated **'Agree'** and 45 percent (n = 76) of the male respondents indicated **'Agree'**. Twenty percent (n = 27) of the female respondents indicated **'Strongly Agree'** and 15 percent (n = 26) of the male respondents indicated **'Strongly Agree'**.

The findings indicate that the majority of both female and male students agree that they are aware that the institution makes use of access testing. However, the minority of both female and male students strongly disagree with this statement.

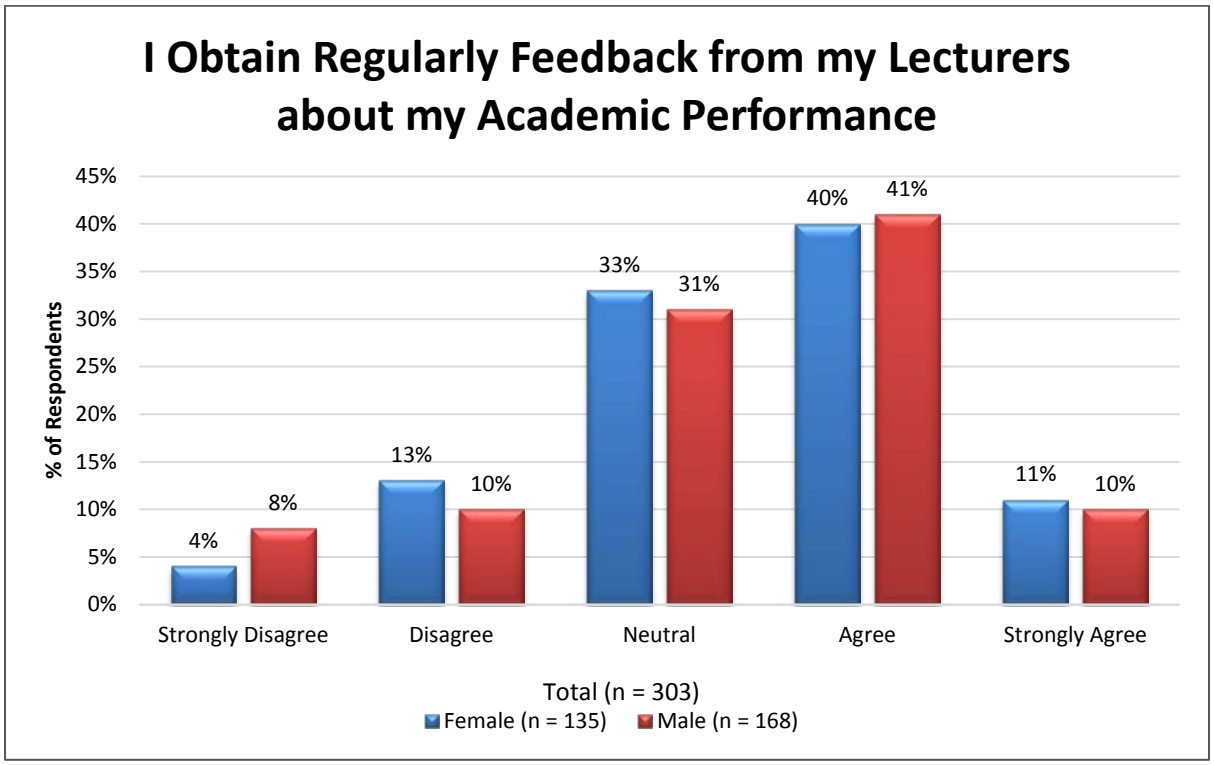

Figure 4.77: I obtain regularly feedback from my lecturers about my academic performance.

Figure 4.77 depicts the total responses (n = 303) received from the female responses (n = 135) and male responses (n = 168) for their opinion whether 'I obtain regularly feedback from my lecturers about my academic performance'. Four percent (n = 5) of the female

respondents indicated **'Strongly Disagree'** and 8 percent (n = 14) of the male respondents indicated **'Strongly Disagree'**. Thirteen percent (n = 17) of the female respondents indicated **'Disagree'** and 10 percent (n = 17) of the male respondents indicated **'Disagree'**. Thirty-three percent (n = 44) of the female respondents indicated **'Neutral'** and 31 percent (n = 52) of the male respondents indicated **'Neutral'**. Forty percent (n = 54) of the female respondents indicated **'Agree'** and 41 percent (n = 69) of the male respondents indicated **'Agree'**. Eleven percent (n = 15) of the female respondents indicated **'Strongly Agree'** and 10 percent (n = 16) of the male respondents indicated **'Strongly Agree'**.

The findings indicate that the majority of both female and male students agree that they obtain regularly feedback from their lecturers about their academic performance. However, the minority of both female and male students strongly disagree with this statement.

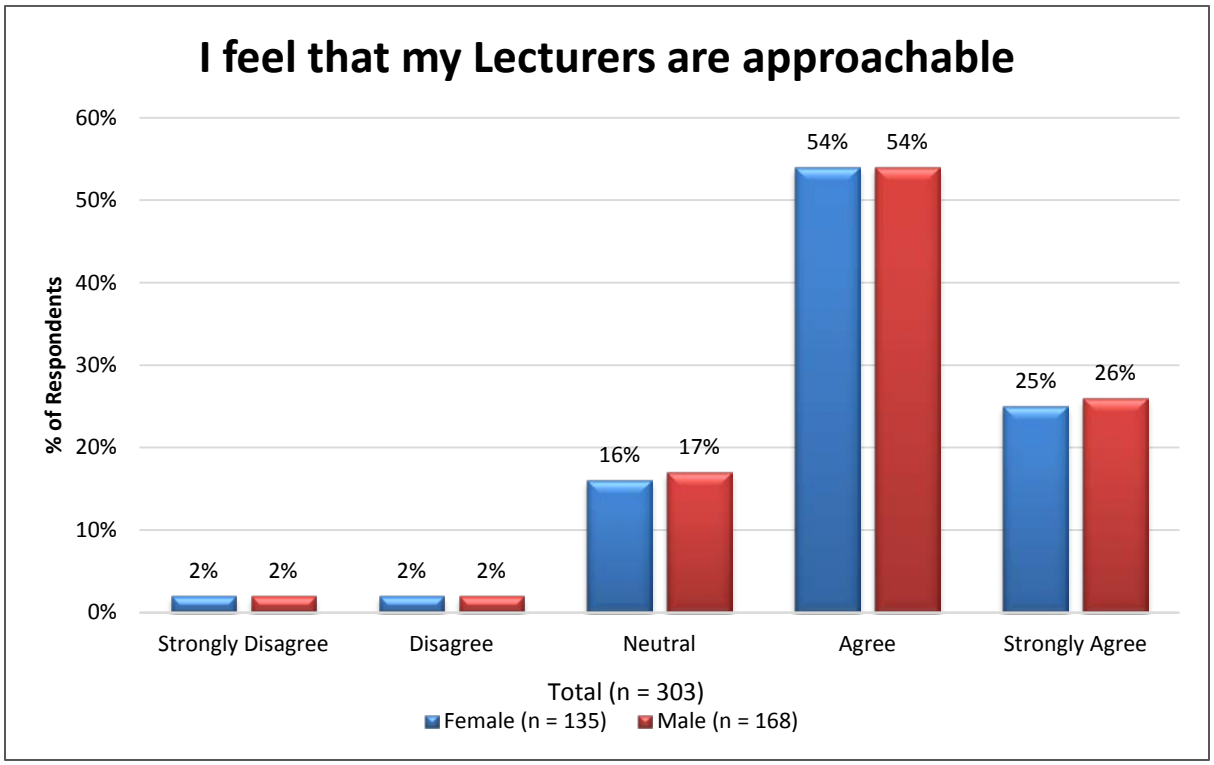

Figure 4.78: I feel that my lecturers are approachable.

Figure 4.78 depicts the total responses (n = 303) received from the female responses (n = 135) and male responses (n = 168) for their opinion whether 'I feel that my lecturers are approachable'. Two percent (n = 3) of the female respondents indicated **'Strongly Disagree'** and 2 percent (n = 3) of the male respondents indicated **'Strongly Disagree'**. Two percent (n = 3) of the female respondents indicated **'Disagree'** and 2 percent (n = 3) of the male respondents indicated **'Disagree'**. Sixteen percent (n = 22) of the female

respondents indicated **'Neutral'** and 17 percent (n = 29) of the male respondents indicated **'Neutral'**. Fifty-four percent (n = 73) of the female respondents indicated **'Agree'** and 54 percent (n = 90) of the male respondents indicated **'Agree'**. Twenty-five percent (n = 34) of the female respondents indicated **'Strongly Agree'** and 26 percent (n = 43) of the male respondents indicated **'Strongly Agree'**.

The findings indicate that the majority of both female and male students agree that they feel that their lecturers are approachable. However, the minority of both female and male students strongly disagree and disagree with this statement.

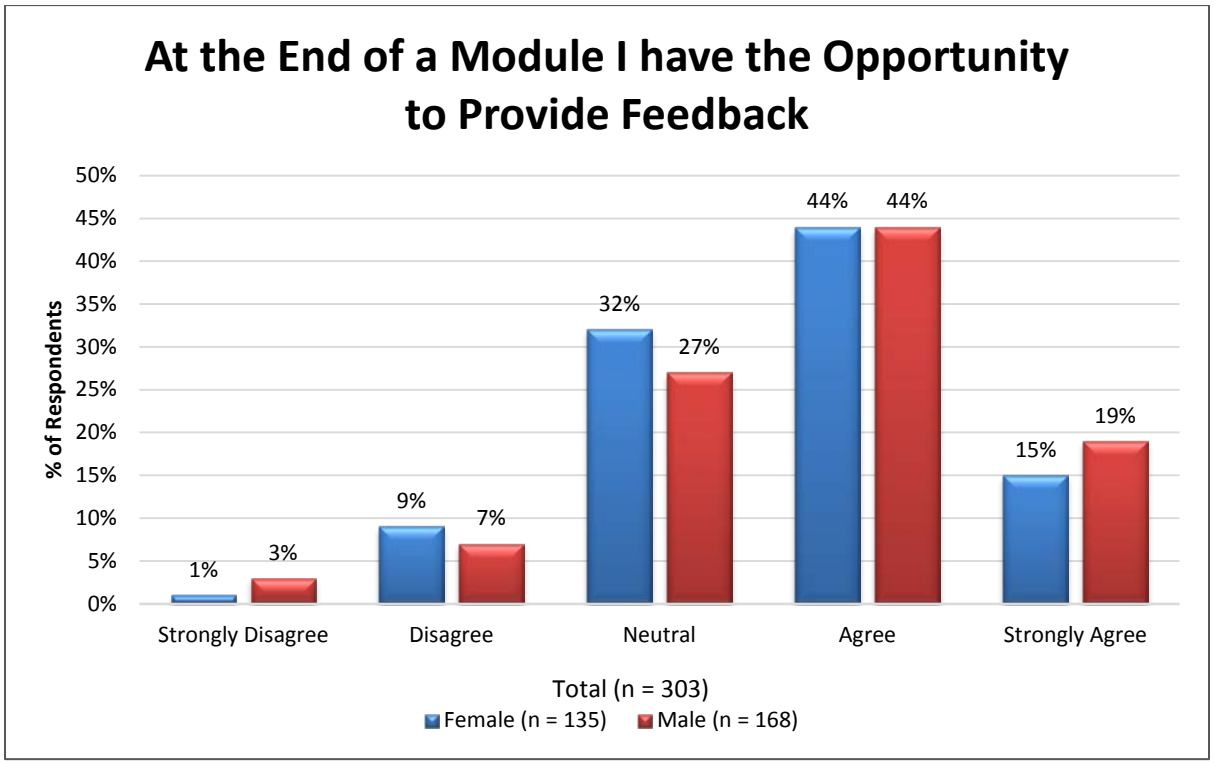

Figure 4.79: At the end of a module I have the opportunity to provide feedback.

Figure 4.79 depicts the total responses (n = 303) received from the female responses (n = 135) and male responses (n = 168) for their opinion whether 'at the end of a module I have the opportunity to provide feedback'. One percent (n = 1) of the female respondents indicated **'Strongly Disagree'** and 3 percent (n = 5) of the male respondents indicated **'Strongly Disagree'**. Nine percent (n = 12) of the female respondents indicated **'Disagree'** and 7 percent (n = 11) of the male respondents indicated **'Disagree'**. Thirty-two percent (n = 43) of the female respondents indicated **'Neutral'** and 27 percent (n = 45) of the male respondents indicated **'Neutral'**. Forty-four percent (n = 59) of the female respondents indicated **'Agree'** and 44 percent (n = 75) of the male respondents indicated **'Agree'**.

Fifteen percent (n = 20) of the female respondents indicated **'Strongly Agree'** and 19 percent (n = 32) of the male respondents indicated **'Strongly Agree'**.

The findings indicate that the majority of both female and male students agree that at the end of a module, they have the opportunity to provide feedback. However, the minority of both female and male students strongly disagree with this statement.

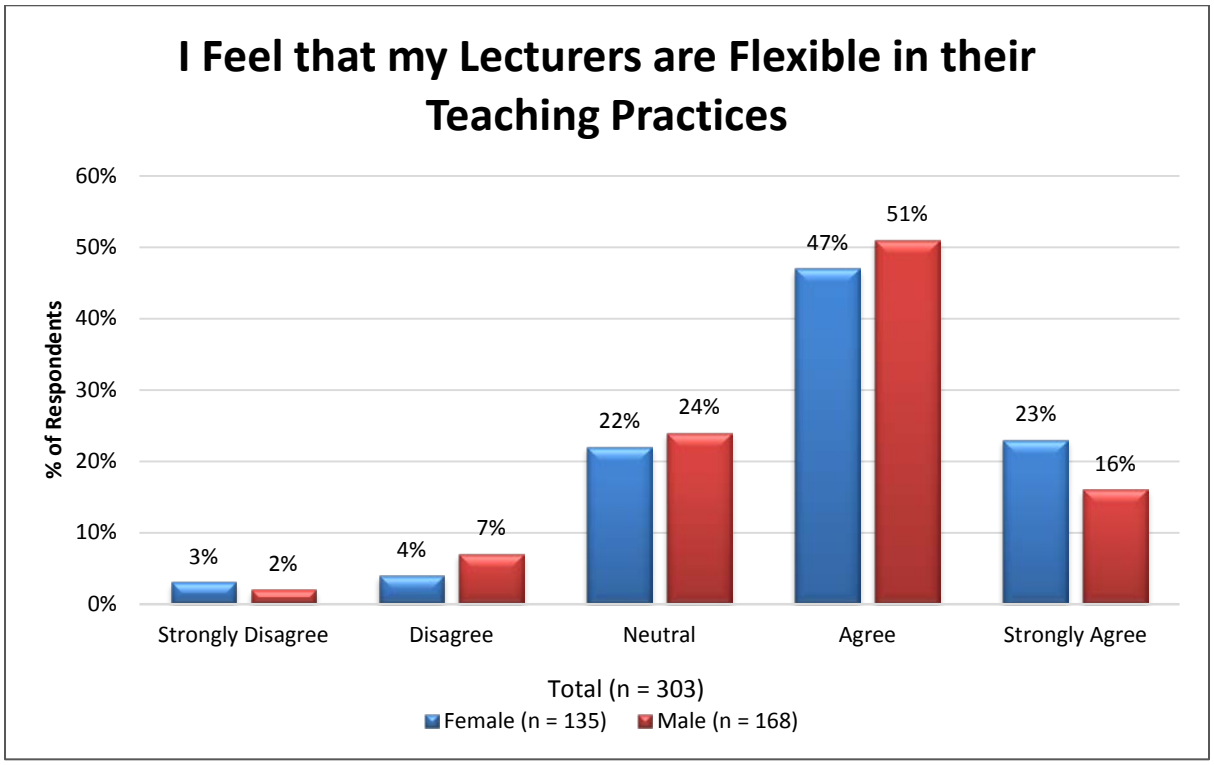

Figure 4.80: I feel that my lecturers are flexible in their teaching practices.

Figure 4.80 depicts the total responses (n = 303) received from the female responses (n = 135) and male responses (n = 168) for their opinion whether 'I feel that my lecturers are flexible in their teaching practices'. Three percent (n = 4) of the female respondents indicated **'Strongly Disagree'** and 2 percent (n = 3) of the male respondents indicated **'Strongly Disagree'**. Four percent (n = 6) of the female respondents indicated **'Disagree'** and 7 percent (n = 11) of the male respondents indicated **'Disagree'**. Twenty-two percent (n = 30) of the female respondents indicated **'Neutral'** and 24 percent (n = 40) of the male respondents indicated **'Neutral'**. Forty-seven percent (n = 64) of the female respondents indicated **'Agree'** and 51 percent (n = 87) of the male respondents indicated **'Agree'**. Twenty-three percent (n = 31) of the female respondents indicated **'Strongly Agree'** and 16 percent (n = 27) of the male respondents indicated **'Strongly Agree'**.

The findings indicate that the majority of both female and male students agree that their lecturers are flexible in their teaching practices. However, the minority of both female and male students strongly disagree with this statement.

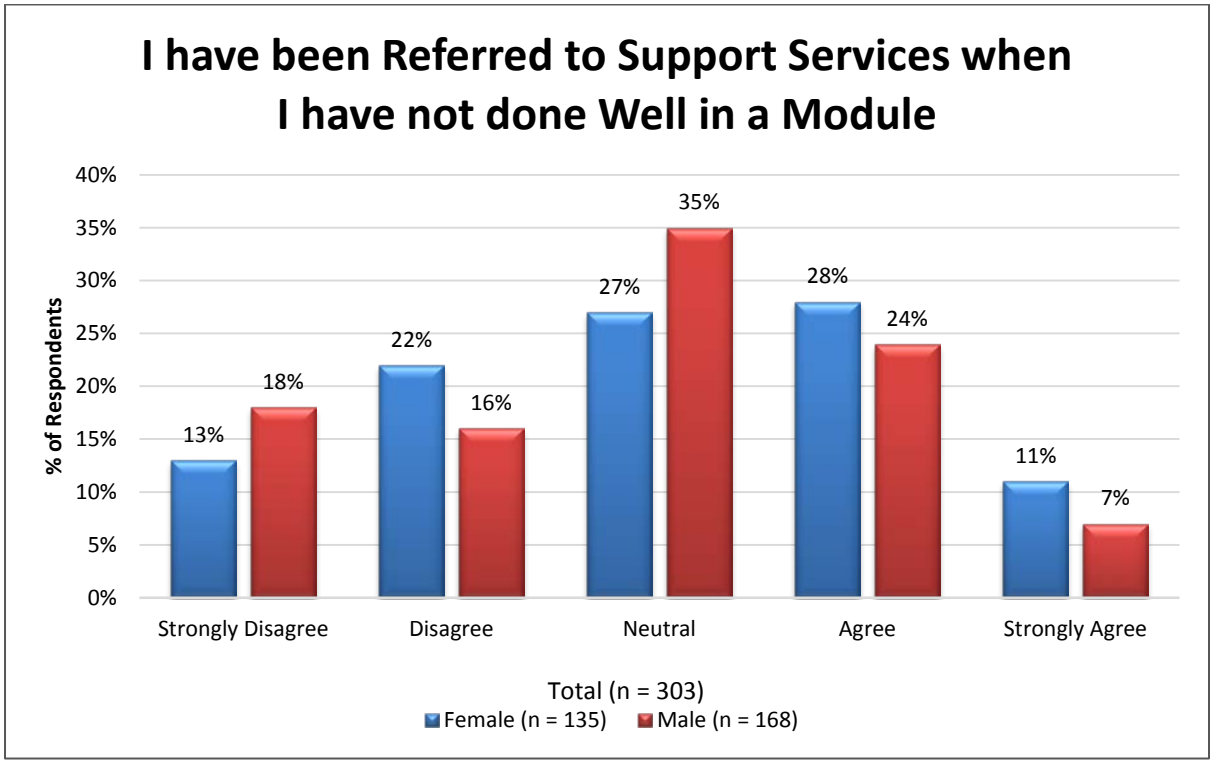

Figure 4.81: I have been referred to support services when I have not done well in a module.

Figure 4.81 depicts the total responses (n = 303) received from the female responses (n = 135) and male responses (n = 168) for their opinion whether 'I have been referred to support services when I have not done well in a module'. Thirteen percent (n = 17) of the female respondents indicated **'Strongly Disagree'** and 18 percent (n = 30) of the male respondents indicated **'Strongly Disagree'**. Twenty-two percent (n = 29) of the female respondents indicated **'Disagree'** and 16 percent (n = 27) of the male respondents indicated **'Disagree'**. Twenty-seven percent (n = 36) of the female respondents indicated **'Neutral'** and 35 percent (n = 60) of the male respondents indicated **'Neutral'**. Twenty-eight percent (n = 38) of the female respondents indicated **'Agree'** and 24 percent (n = 40) of the male respondents indicated **'Agree'**. Eleven percent (n = 15) of the female respondents indicated **'Strongly Agree'** and 7 percent (n = 11) of the male respondents indicated **'Strongly Agree'**.

The findings indicate that the majority of female students agree that they have been referred to support services when they have not done well in a module and the majority of male students indicated neutral to this statement. The high response rate on 'Neutral' from both

genders could be to avoid negative feelings associated with their conflicting feelings towards this statement or they are unsure regarding this statement. However, the minority of both female and male students strongly agree with this statement.

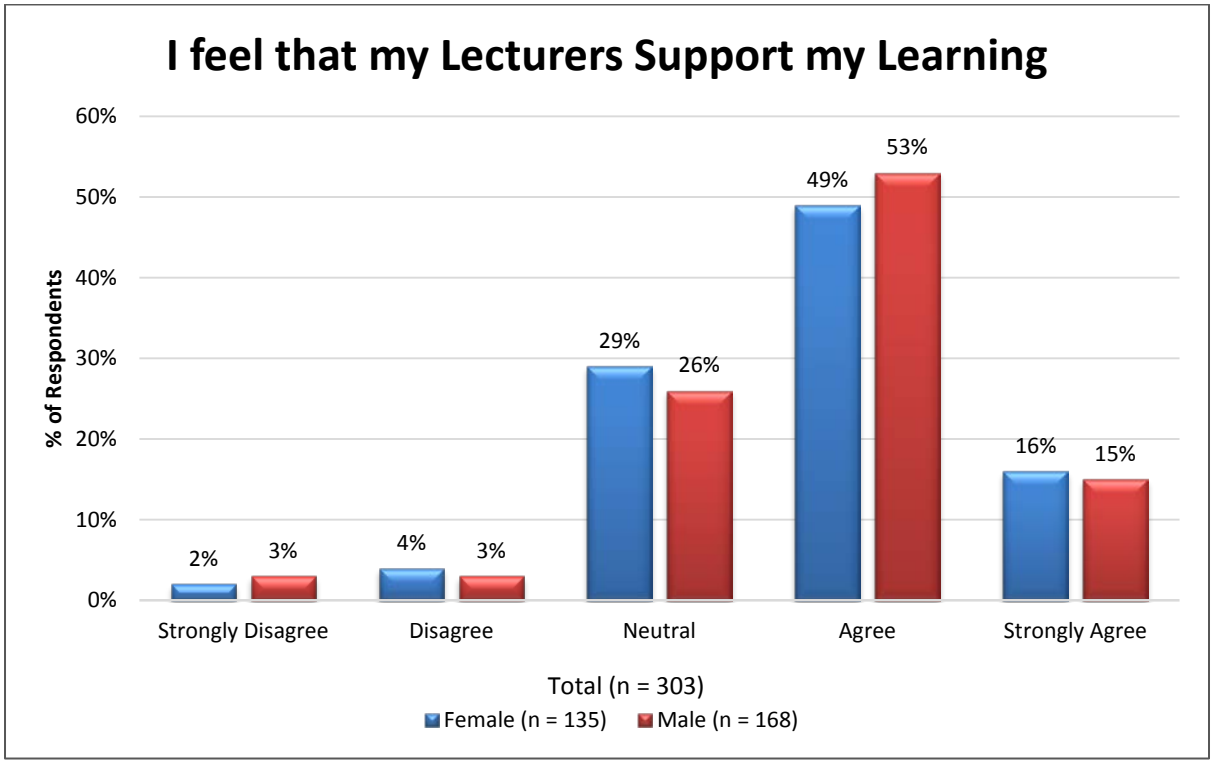

Figure 4.82: I feel that my lecturers support my learning.

Figure 4.82 depicts the total responses (n = 303) received from the female responses (n = 135) and male responses (n = 168) for their opinion whether 'I feel that my lecturers support my learning'. Two percent (n = 3) of the female respondents indicated **'Strongly Disagree'** and 3 percent (n = 5) of the male respondents indicated **'Strongly Disagree'**. Four percent (n = 5) of the female respondents indicated **'Disagree'** and 3 percent (n = 5) of the male respondents indicated **'Disagree'**. Twenty-nine percent (n = 39) of the female respondents indicated **'Neutral'** and 26 percent (n = 43) of the male respondents indicated **'Neutral'**. Forty-nine percent (n = 66) of the female respondents indicated **'Agree'** and 53 percent (n = 89) of the male respondents indicated **'Agree'**. Sixteen percent (n = 22) of the female respondents indicated **'Strongly Agree'** and 15 percent (n = 26) of the male respondents indicated **'Strongly Agree'**.

The findings indicate that the majority of both female and male students agree that their lecturers support their learning. However, the minority of both female and male students strongly disagree with this statement.

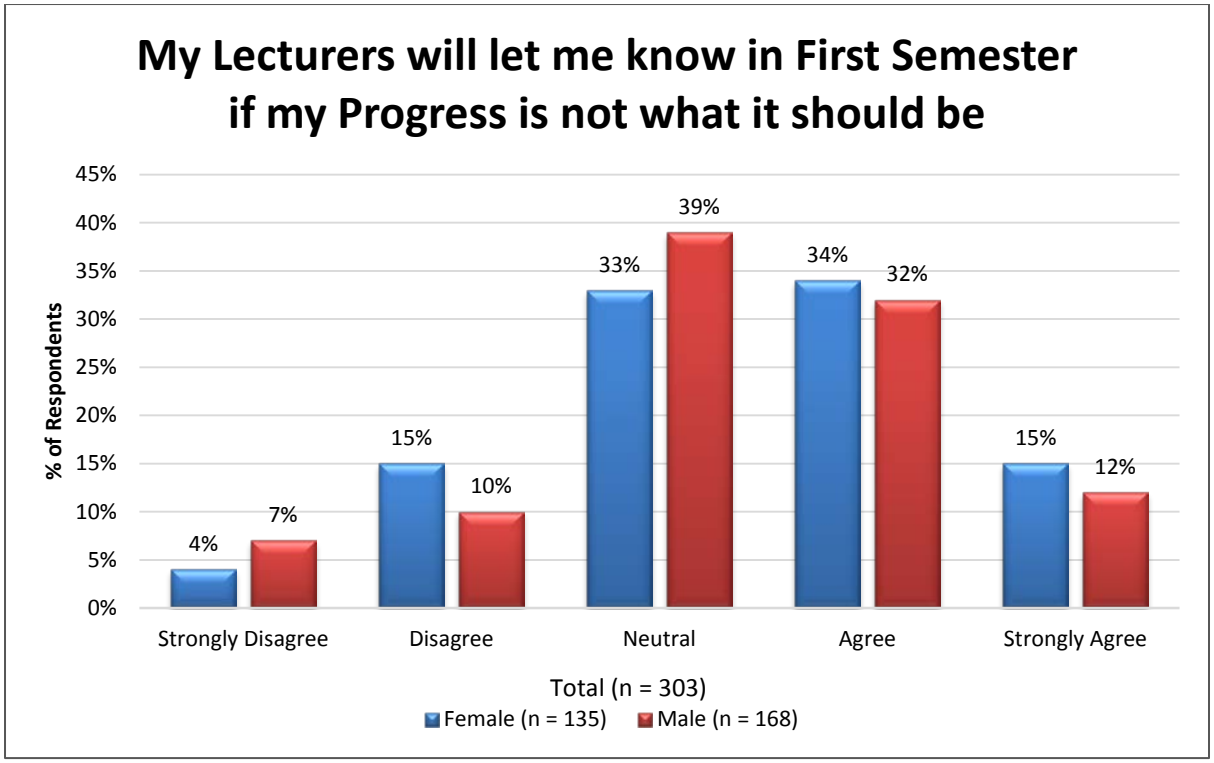

Figure 4.83: My lecturers will let me know in first semester if my progress is not what it should be.

Figure 4.83 depicts the total responses (n = 303) received from the female responses (n = 135) and male responses (n = 168) for their opinion whether 'my lecturers will let me know in first semester if my progress is not what it should be'. Four percent (n = 5) of the female respondents indicated **'Strongly Disagree'** and 7 percent (n = 12) of the male respondents indicated **'Strongly Disagree'**. Fifteen percent (n = 20) of the female respondents indicated **'Disagree'** and 10 percent (n = 17) of the male respondents indicated **'Disagree'**. Thirty-three percent (n = 44) of the female respondents indicated **'Neutral'** and 39 percent (n = 65) of the male respondents indicated **'Neutral'**. Thirty-four percent (n = 46) of the female respondents indicated **'Agree'** and 32 percent (n = 54) of the male respondents indicated **'Agree'**. Fifteen percent (n = 20) of the female respondents indicated **'Strongly Agree'** and 12 percent (n = 20) of the male respondents indicated **'Strongly Agree'**.

The findings indicate that the majority of female students agree that their lecturers will let them know in first semester if their progress is not what it should be and the majority of male students indicated neutral to this statement. The high response rate on 'Neutral' from both genders could be that they are unsure regarding this statement. However, the minority of both female and male students strongly disagree with this statement.

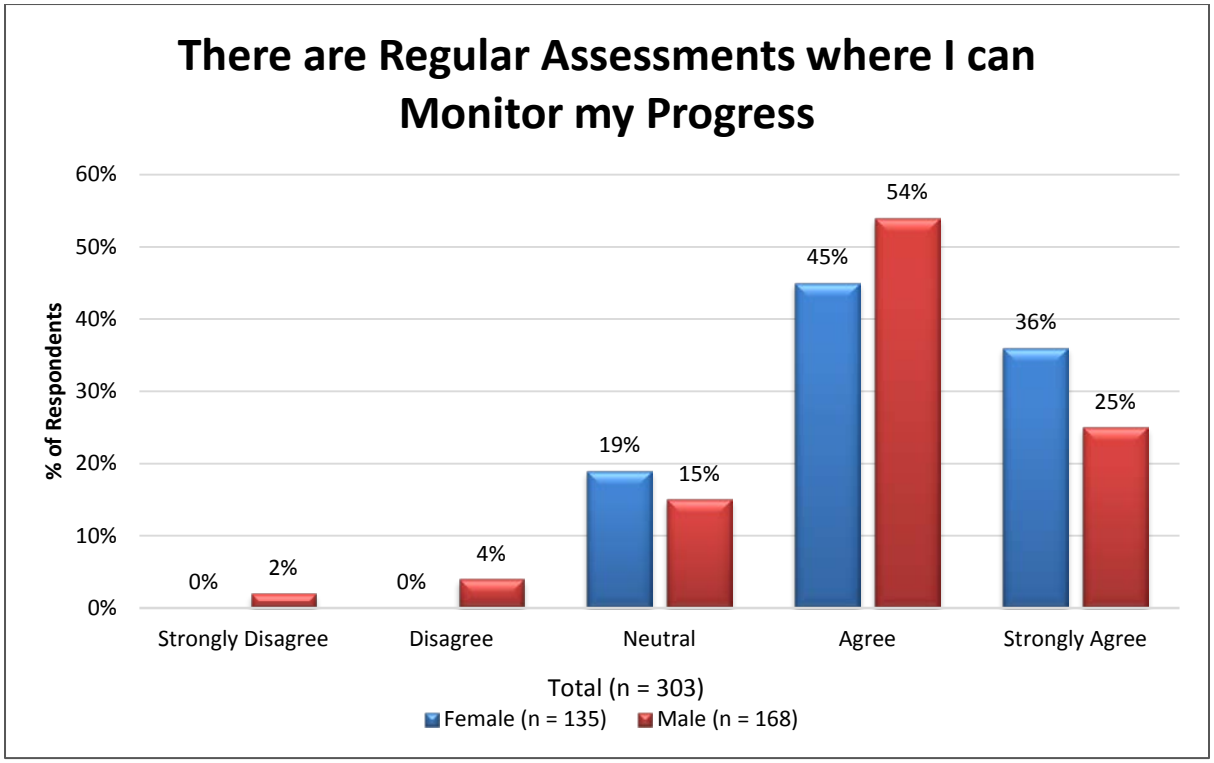

Figure 4.84: There are regular assessments where I can monitor my progress.

Figure 4.84 depicts the total responses (n = 303) received from the female responses (n = 135) and male responses (n = 168) for their opinion whether 'there are regular assessments where I can monitor my progress'. None of the female respondents indicated **'Strongly Disagree'** and 2 percent (n = 3) of the male respondents indicated **'Strongly Disagree'**. None of the female respondents indicated **'Disagree'** and 4 percent (n = 7) of the male respondents indicated **'Disagree'**. Nineteen percent (n = 25) of the female respondents indicated **'Neutral'** and 15 percent (n = 26) of the male respondents indicated **'Neutral'**. Forty-five percent (n = 61) of the female respondents indicated **'Agree'** and 54 percent (n = 90) of the male respondents indicated **'Agree'**. Thirty-six percent (n = 49) of the female respondents indicated **'Strongly Agree'** and 25 percent (n = 42) of the male respondents indicated **'Strongly Agree'**.

The findings indicate that the majority of both female and male students agree that there are regular assessments where they can monitor their progress. However, the minority of both female and male students strongly disagree with this statement.

Variable	T-tests; Grouping: Gender								
	Mean (1)	Mean (2)	t-value	df	p	Valid N (1)	Valid N (2)	Std Dev. (1)	Std Dev. (2)
Feedback	3.66	3.58	1.1522	301	0.25014	135	168	0.57534	0.60125

Table 4.11: T-tests on Gender with Feedback variables.

Table 4.11 indicates a t-test conducted on gender regarding their experience regarding the support they receive from the faculty. $p > 0.05$ which indicates that no significant difference exists between the two genders with regard to feedback from the faculty. The mean for both female and male students is three, indicating that the average for both genders indicated 'neutral' on the above variables. The Cronbach Alpha for this construct was established as 0.80 indicating moderate reliability.

The following sub-section will summarise the research findings of Section 5.

4.3.2.9. Summary of Research Findings in Section 5

Section 5 – Faculty Related Questions was used to collect information regarding the perceptions of students, in relation to the Faculty of Engineering. According to the findings from Section 5 – Faculty Related Questions as discussed in detail above, the following can be highlighted. The findings clearly indicate that the majority of both female and male students indicated that the faculty should not offer separate tutorials for female-only or male-only classes, that female students are able to cope with the workload in the laboratories or workshops, that lecturers does not prefer teaching male only classes and that academic staff does not discriminate against female students. The majority of female students indicated that male students do not dominate discussions during class. The majority of female students also indicated that the number of female lecturers within the faculty is insufficient. As mentioned before, female academic staff serve as role models and mentors for female students.

The majority of both female and male students indicated that they do receive regularly feedback regarding their academic performance, they are allowed to provide feedback of the module and that their lecturers are approachable. Both genders also indicated that they receive support from the lecturers. This clearly indicates that both genders experience the same feedback from the faculty, indicating that staff members treat female and male students the same. As mentioned before, support from staff members is important, as this will result into attracting and retaining students towards the faculty of engineering.

The following section will summarise the chapter.

4.4. Summary

This chapter addressed RQ_4 which states, "*What are the significant differences between male and female students for choosing a career in engineering?*" and RQ_5 which states

"*What are the challenges that female students encounter while studying engineering*". The chapter completed RO_4, namely to identify the significant differences between male and female students for choosing a career in engineering. This chapter also completed RO_5, namely to identify the challenges that female students encounter while studying engineering.

Chapter 4 was focused on the analysis and interpretation of the data, which has been collected. Both descriptive statistics and inferential statistics has been used in order to demonstrate common trends as well as uniqueness of the findings.

Chapter 5 will provide a summary of the research findings, which was presented, the limitations of this study and future research. Therefore, this chapter will be concluded by referring to RQ_M, which questions "*What attracts female students studying towards a field in Engineering?*"

5. CONCLUSIONS AND RECOMMENDATIONS

5.1. Introduction

The empirical results were collected, analysed and presented in Chapter 4. The chapter focused on the findings of the Engineering Survey. The Engineering Survey was distributed to all Engineering students registered for an undergraduate qualification at Nelson Mandela University. The findings of the survey were compiled, analysed and presented in a logical manner. Current literature was reviewed that were aligned with the overall research question and research objective.

Chapter 5 addresses RQ_M, which states "*What attracts female students to study Engineering?*". The main objective for this chapter is to determine the factors that affect female students studying towards a field in Engineering at a Higher Education Institution. Firstly, engineering was reviewed internationally and locally. It was discussed how crucial it is to produce good quality engineers to fit into this demanding industry, in order to improve the society. Thus, Higher Education Institutions have to produce good quality engineers after graduation. Therefore, it is their responsibility to attract and retain female students to study towards a field in engineering, as it is labelled as a male dominant career. It is important to break this stereotype, because female students can also become excellent engineers. Secondly, in this research study, the research methodology was discussed. Lastly, an empirical study was conducted by evaluating the findings of the survey.

A summary of the research process follows in Chapter 5. This includes a summary of the research, recommendations and considerations, limitations of the study and future research to be conducted. See Figure 5.2 for a Structural overview of Chapter 5.

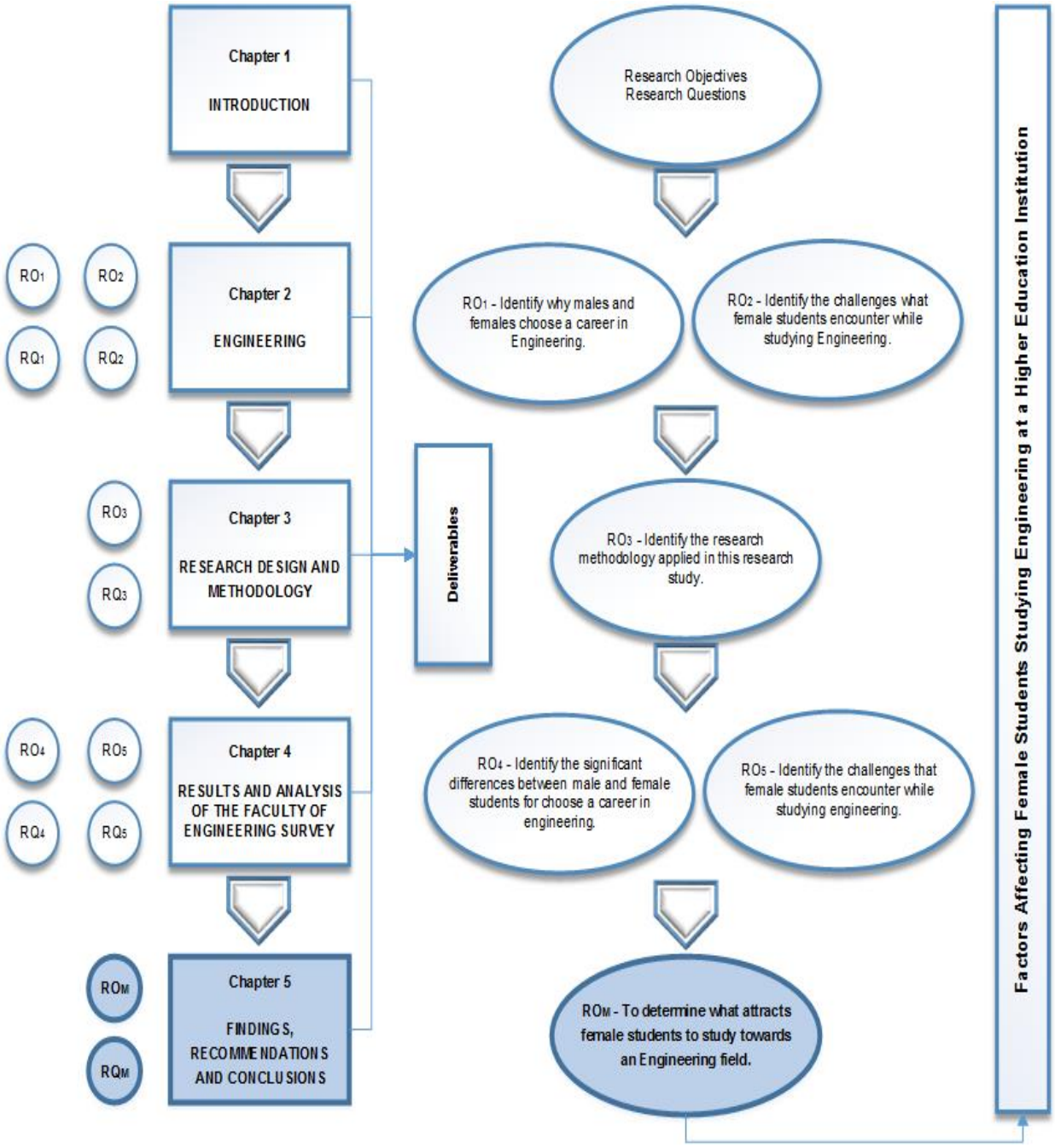

Figure 5.1: Overview of Chapter 5's Research Objectives.

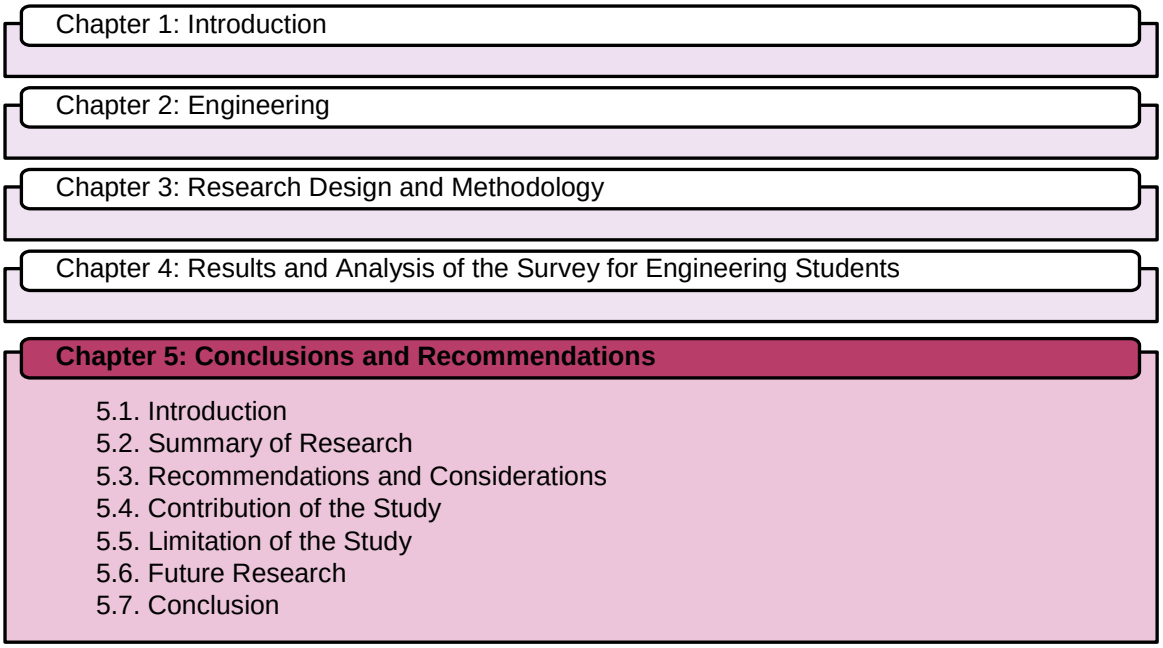

Figure 5.2: Structural overview of Chapter 5.

5.2. Summary of the Research

The research study constituted various research questions that were identified and analysed in order to address the main research question. The following sub-section discuss these research questions research objectives.

5.2.1. Main Research Question (RQ_M) and Research Objective (RO_M)

The Main Research Question of the research study was stated as "*What attracts female students to study Engineering?".* The following five research questions (**RQ_1** to **RQ_5**) based on the secondary research objectives, had to be answered first, in order to evaluate the main research problem effectively:

RQ_1 - *Why do male and female students choose a career in engineering?*

RQ_2 - *What challenges do female students encounter while studying engineering?*

RQ_3 - *What research methodology can be used for this study?*

RQ_4 - *What are the significant differences between male and female students for choosing a career in engineering?*

RQ_5 - *What are the challenges that female students encounter while studying engineering?*

5.2.2. Research Question RQ_1 and Research Objective (RO_1)

The first research question (RQ_1) states "*Why do male and female students choose a career in engineering?*". The objective of this question was to identify why males and females choose a career in engineering. A literature study was conducted in Chapter 2 in order to answer this question. Firstly, the vital role engineering plays internationally and within South Africa was elaborated on. Secondly, it continued with the performance of women in the workplace and especially women in engineering. Thereafter, the reasons of both females and males for choosing engineering was demonstrated. Women take on a rational thinking approach in order to choose a career in engineering, which involves career and job opportunities (Holth, 2014).

5.2.3. Research Question (RQ_2) and Research Objective (RO_2)

The second research question (RQ_2) states "*What challenges do female students encounter while studying engineering?*". The objective of this question was to identify the challenges that female students encounter while studying engineering. The literature study continued in the last section of Chapter 2, in order to answer this question. The last section elaborated on female students studying towards a field in engineering, including various challenges female students may encounter. These challenges include female students face difficulties in their interpersonal relationships, engineering qualifications are too theoretical, not interesting and tutorials were not considered as useful (Cadaret et al., 2016; Kolari et al., 2006). These factors may discourage female students from furthering their studies or even completing their current qualification in engineering. This chapter concludes that university support is very important. The number of female academic staff members serve as role models for female students.

5.2.4. Research Question (RQ_3) and Research Objective (RO_3)

The third research question (RQ_3) states "*What research methodology can be used for this study?*". The objective of this question was to identify the research methodology applied in this research study. In Chapter 3, research was defined, following a discussion on the research philosophy, the research approach, research strategies, time horizons and techniques and procedures used in this study. For the purpose of this study, the chosen methods are positivism, deductive reasoning, surveys and cross-sectional studies were identified. The population, the sample and sampling techniques were identified. The strengths and weaknesses of the data collection methods were mentioned. The reliability and validity were discussed. This chapter concluded with the research paradigm.

5.2.5. Research Question (RQ_4) and Research Objective (RO_4)

This fourth research question (RQ_4) states "*What are the significant differences between male and female students for choosing a career in engineering?*". The objective of this question was to identify the significant differences between male and female students when choosing a career in engineering. In order to find a suitable answer to the identified research question, current literature studies were reviewed. From the findings of the current literature studies, an engineering survey was compiled and distributed to all Nelson Mandela University students studying towards an undergraduate qualification in Engineering. The data collected from the survey was analysed and presented in a logical manner in Chapter 4. From these findings, the significant differences between female and male students for choosing a career in engineering include that they enjoy problem-solving activities; enjoy designing and creating activities; variety of career opportunities and they always wanted to be an engineer, to name a few.

5.2.6. Research Question (RQ_5) and Research Objective (RO_5)

This fifth research question (RQ_5) states "*What are the challenges that female students encounter while studying engineering?*". The objective of this question was to identify the challenges that female students encounter while studying engineering. In order to find a suitable answer to the identified research question, current literature studies were reviewed. From the findings of the current literature studies, an engineering survey was compiled and distributed to all Nelson Mandela University students studying towards an undergraduate qualification in Engineering. The data collected from the survey was analysed and presented in a logical manner in Chapter 4.

5.3. Recommendations and Considerations

The literature study clearly indicated the importance that excellent engineers are needed, especially female engineers in this male-dominant career. Research has indicated that there is a great demand for engineering professionals and therefore, awareness should already be created at high school level, as well as at a higher education level. The quality of the matriculants entering a higher education level are decreasing and thus universities have to work harder to improve the quality of students finishing their qualifications (Moodley, 2014). Awareness should be created and thus, it is recommended for universities to work with schools to develop the level of mathematics and physical sciences at a young age before entering a higher education level. This will increase the group of possible quality students entering the field of engineering.

Female students are still in the minority in this male-dominant career (Stonyer, 2002). In order for female students to pursue a career in engineering, they need to overcome the lack of self-confidence, lack of comfort and lack of experience with numerous tools. Reasons for not choosing a career in engineering could include social influences, past experiences or even a female's own perception about certain fields (Bodner et al., 2006). Therefore, the recommendation here would be that universities need to assist in this regard or create opportunities regarding this matter, as female students studying engineering has a tendency to experience these feelings when entering a higher education institution (Johnson et al., 2013).

Female students need motivation and role models in engineering to guide and assist them. More female academic staff should be promoted. Female academic staff serve as role models for female students, in order to attract and retain female students (Mills, 2011). This includes the motivation from female academic staff on the students total study time and the amount of workload required for female students to complete their qualifications (Cadaret et al., 2016; Kolari et al., 2006).

5.4. Contribution of the Study

This research study has proposed factors for understanding female students studying towards a career in engineering. Therefore, the following contributions may be proposed:

- Misperceptions regarding both gender's interest, abilities and encouragements were identified; and
- The type of student who enters a Higher Education Institution differs each year and therefore, universities are benefitting from this treatise in order to be prepared for the future.

In addition, this treatise established that when choosing a career in engineering, female students are not very different from their male counterparts. Thus, they receive the same information regarding engineering and quality education. External factors play an important part with females, which may range from school teachers, parents, cultural norms, social pressures or even an interest in mathematics and science. When it comes to choosing a career or job opportunities, female students use a rational thinking approach opposed to male students. However, being the minority during their university years, they need extra motivation and role models, such as female mentorship programmes and female academic staff.

5.5. Limitations of the Study

During any research study, some shortcomings, influences, conditions or even weaknesses that are outside the control of the researcher, which may place restrictions on the research study. This is also known as limitations of the study (Collis & Hussey, 2014). The following are limitations that have been identified in this research study:

- Some questions in the survey may be of a sensitive matter and therefore, the respondents may not choose the true answer, but rather the more appropriate answer;
- A higher response rate would have assisted the study more. The smaller sample size, could be due to the study being a non-probability or convenience sampling, which allows easy access to the respondents for the researcher;
- Although the online survey tool is an excellent tool for guaranteeing the anonymity of the respondents and simplifying the data capturing process, the researcher does not have a control over respondents not completing the online survey in full. For this treatise, in total 551 respondents started the online survey, but never completed it. Only 303 respondents completed the survey;
- Due to being a cross-sectional study, anything before or after this study is excluded, as this only includes the current circumstances at the time of the set timeframe;
- Some of the respondents may have some difficulty understanding the questions being asked and therefore misinterpret some questions; and
- This study was only conducted at one university in South Africa. If other universities were approached, a larger number of responses would have been received and the results may differ. The different responses from other universities in South Africa could be compared, to realise whether other engineering students' experiences, would be the same.

5.6. Future Research

During the course of this research study, several different future research possibilities have been identified that will assist future research to strengthen the findings as presented. These future research possibilities are:

- A study conducted only on senior students may provide more accurate and reliable information;
- Future research should explore the factors contributing to the demeaning perceptions women in engineering have;
- An investigation should be conducted on how classroom experiences and course feedback might be influencing the competence of female students in a male-dominant environment;

- Collecting data from multiple institutions of higher education in South Africa should be conducted in order to receive a larger sample size;
- Investigate the attraction of students towards engineering by introducing a 'bridging programme', in order to assist students who does not make direct entry towards an engineering qualification;
- Future research should be conducted to receive more information regarding gender bias under engineering students. Will personal relationship, such as friendships, reduce gender bias;
- Future research conducted on women currently in engineering professions and how they experience the challenges being in a male-dominant career; and
- An investigation in adapting or improving engineering education. Higher education institutions need to deliver young capable and competent engineering graduates, who meet the needs of the demanding industry of engineers.

5.7. Conclusion

The main objective of this research study was to determine the factors that affect female students while studying towards a field in Engineering at a Higher Education Institution. In order to achieve the main objective the following deliverables were set, which included:

- Perform a literature study on why both genders choose engineering and challenges female students encountered while studying engineering;
- Explain the research methodology applied in this research study;
- Conduct a comprehensive analysis of the collected empirical data;
- Establish reasons for choosing engineering, including external influences and encouragements; and
- Establish possible factors that influence female students while studying engineering, which allows Nelson Mandela University to improve these experiences for female students.

This research study indicated the importance of engineering, in order to improve or increase sustainability, needs of society, necessary risks, protecting the environment and improving the efficiency use of resources (Bell, 2011; ECSA, 2015). Therefore, universities are responsible for delivering competent, quality, employable engineers in order to meet the demanding needs of the industry. Thus, being a male-dominant environment, female students need to receive the relevant knowledge and skills when entering the workplace (Franzway et al., 2008). Thus, it is very important for universities to equip the female

students with the necessary knowledge and skills that are required for high productivity and performance (Baytiyeh & Naja, 2012).

The research study concluded with a list of recommendations and considerations that were derived from the findings of the engineering survey. The key recommendations are that there is a great demand for female engineers. Therefore, awareness should be created at high school level. The quality of matriculants entering the university is decreasing. It is recommended that universities work with schools to develop an interest in mathematics and physical science at a young age before entering a higher education level. This will increase the group of possible quality students entering the field of engineering. Thereafter, opportunities for future research were outlined, contribution of the study was listed and limitations of this study were identified. This study determined the engineering students' experience and perceptions while studying towards a field in engineering at Nelson Mandela University. The focus was female students. Female and male students studying engineering have the same perception towards why choosing to study engineering as a career. In addition, they receive the same quality education regarding their studies. Their influences and encouragements are similar. Female academic staff play a major role for female students. Therefore, Nelson Mandela University need to assure that they use this as a guideline in order to attract and retain female students towards a field in engineering.

REFERENCES

Adams, S., 2015. *The College Degrees With the Highest Starting Salaries in 2015*. [Online]. Available: http://www.forbes.com/sites/susanadams/2014/11/19/the-college-degrees-with-the-highest-starting-salaries-in-2015/#66b9325b96a2 [Accessed 22 April 2016].

Allen, T.O. and Zhang, Y., 2016. Dedicated to Their Degrees: Adult Transfer Students in Engineering Baccalaureate Programs. *Community College Review 2016*, Vol. 44(1), pp. 70 – 86.

Alpay, E., 2013. Student attraction to engineering through flexibility and breadth in the curriculum. *European Journal of Engineering Education*, 38(1), pp. 58 – 69.

Alwi, S.R.W., Manan, Z.A. and Klemes, J.J., 2014. Sustainability engineering for the future. *Journal of Cleaner Producation*, 71(1), pp. 1 – 10.

Ayre, M. and Roberts, P., 2002. Did she Jump or was she Pushed? A Study of Women's Retention in the Engineering Workforce. *International Journal of Engineering Education*, 18(4), pp. 415 – 421.

Babbie, E.R., 2010. *Doing Quantitative Research in Education*. 2nd ed. London: SAGE Publications.

Baillie, C. and Fitzgerald, G., 2000. Motivation and attrition in engineering students. *European Journal of Engineering Education*, 25(2), pp. 145 – 155.

Barkhuizen, Y. and Du Plessis, N., 2015. Exploring the career path barriers of women professional engineers in a South African context. *South African Journal of Labour Relations*, 39(1), pp. 38 – 57.

Bates, E., 2015. *Matric pass rate drops nationally*. [Online]. Available: http://www.enca.com/south-africa/matric-pass-rate-drops-nationally [Accessed 28 June 2015].

Baytiyeh, H. and Naja, M., 2012. Identifying the challenging factors in the transition from colleges of engineering to employment. *Journal of Engineering Education*, 37(1), pp. 39 – 47.

Bell, E. and Bryman, A., 2007. Business research methods. New York: Oxford University Press.

Bell, S., 2011. Engineers, Society, and Sustainability. *Synthesis Lectures on Engineers, Technology, and Society*, 6(3), pp. 109 – 118.

Berry, F.C., DiPiazza, P.S. and Sauer, S.L., 2003. The Future of Electrical and Computer Engineering Education. *IEEE Transactions on Education*, 46(4), pp. 467 – 476.

Bertin, J.J., Brandt, S.A., Stiles, R.J. and Whitford R., 2004. *Introduction to Aeronautics: A Design Perspective*. Virginia: American Institute of Aeronautics and Astronautics, Inc.

Bhamidimarri, R. and Liu, A., 2016. *Engineering and Enterprise – Inspiring Innovation*. Switzerland: Springer International Publishing.

Bodner, G.M., Follman, D.K., Hutchison, M.A. and Sumpter, M., 2006. Factors Influencing the Self-Efficacy Beliefs of First-Year Engineering Students. *Journal of Engineering Education*, pp. 39 – 47.

Bradley, D., Russell, D., Ferguson, I., Isaacs, J., MacLeod, A. and White, R., 2015. The Internet of Things – The future or the end of mechatronics. *Mechatronics*, 27(1), pp. 57 – 74.

Brannan, J., 2005. Mixing Methods: The Entry of Qualitative and Quantitative Approaches into the Research Process. *International Journal of Social Research Methodology*, 8(3), pp. 173 – 184.

Bronzino, J.D. and Enderle, J.D., 2012. *Introduction to Biomedical Engineering*. 3rd ed. Amsterdam: Elsevier Inc.

Brunnschweiler, C.N., 2008. Cursing the Blessings? Natural Resource Abundance, Institutions and Economic Growth. *World Development*, 36(3), pp. 399 – 419.

Burke, R.J. and Major, D.A., 2014. *Gender in Organisations*, Northampton: Edward Elgar Publishing Inc.

Burke, R.J. and Mattis, M.C., 2007. *Women and Minorities in Science, Technology, Engineering and Mathematics*, Cornwall: Edward Elgar Publishing Inc.

Cadaret, M.C., Hartung, P.J., Subich, L.M. and Weigold, I.K., 2016. Stereotype threat as a barrier to women entering engineering careers. *Journal of Vocational Behavior*, 99(1), pp. 40 – 51.

Callans, M., 2012. Reliability and Validity in Testing – What do They Mean? [Online]. Available: http://www.wonderlic.com/reliability-and-validity-in-testing-what-do-they-mean [Accessed 27 August 2016].

Centre for Advancement of Scholarship on Engineering Education (CASEE), 2005. Survey Measuring Student and Faculty Engagement in Engineering Education. [Online]. Available: https://www.google.co.za/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&cad=rja&uact=8&ved=0ahUKEwioajb3MTMAhWkHsAKHU2cCKgQFggaMAA&url=https%3A%2F%2Fwww.nae.edu%2FFile.aspx%3Fid%3D16350&usg=AFQjCNEAwTHD9pyabBeuPP8o68_pQ1uXSA&bvm=bv.121421273,d.d2s [Accessed 27 September 2015].

Chamie, J., 2014. *Women More Educated than Men but Still Paid Less*. [Online]. Available: http://yaleglobal.yale.edu/content/women-more-educated-men-still-paid-less-men [Accessed 1 April 2016].

Christensen, L.B. and Johnson, R.B., 2012. *Educational Research: Quantitative, Qualitative and Mixed Approaches*. Alabama: SAGE Publications Inc.

Collis, J. and Hussey, R., 2014. *Business Research: A Practical Guide for Undergraduate and Postgraduate Students*. 4th ed. London: Palgrave Macmillan.

Cooper, D.R. and Schindler, P.S. 2011. *Business Research Methods*. 11th ed. New York: McGraw-Hill.

Creswell, J.W., 2008. *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches.* 3rd ed. CA: SAGE Publications.

Creswell, J. W., 2014. *Research Design.* 4th ed. CA: SAGE Publications.

Davidson, C.I., Hendrickson, C.T., Matthews, H.S., Bridges, M.W., Allen, D.T., Murphy, C.F., Allenby, B.R., Crittenden, J.C. and Austin, S., 2010. Preparing future engineers for challenges of the 21st century: Sustainable engineering. *Journal of Cleaner Production, 18(7)*, pp.698 – 701.

Denn, M.M., 2012. *Chemical Engineering: An Introduction*. New York: Cambridge University Press.

Department of Higher Education and Training, 2016. *2015 National Senior Certificate Examination Report*. Republic of South Africa.

Department of Labour, 2015. *Employment Equity Act of South Africa 1998*. Republic of South Africa.

De Silva, C.W., 2016. *Sensors and Actuators: Engineering System Instrumentation*. 2nd ed. Florida: CRC Press.

Devillard, S., Dobbs, R., Ellingrud, K., Krishnan, M., Kutcher, E., Labaye, E., Madgavkar, A., Manyika, J. and Woetzel, J., 2015. *How advancing women's equality can add $12 trillion to global growth*. [Online]. Available: http://www.mckinsey.com/global-themes/employment-and-growth/how-advancing-womens-equality-can-add-12-trillion-to-global-growth [Accessed 13 May 2016].

Dowling, A., 2015. *Why engineering should be a woman's game*. [Online]. Available: http://www.bbc.com/news/uk-30876899 [Accessed 2 April 2016].

Drost, E., 2011. Validity and Reliability in Social Science Research. *Education Research and Perspectives*, 38(1), pp. 105 – 123.

Engineering Council of South Africa (ECSA), 2015. *What is Engineering?* [Online]. Available: https://www.ecsa.co.za/engineeringsa/SitePages/What%20is%20Engineering.aspx [Accessed 26 June 2015].

EnvironmentalScience, 2016. *What is an Agricultural Engineer*? [Online]. Available: https://www.environmentalscience.org/career/agricultural-engineer [Accessed 4 April 2016].

Eriksson, P. and Kovalainen, A., 2014. *Qualitative Methods in Business Research – A Practical Guide to Social Research*. 2nd ed. Los Angeles: SAGE Publications.

Forbes, 2016. The best jobs for 2015. [Online]. Available: http://www.forbes.com/pictures/mkl45ejejl/ [Accessed 20 April 2016].

Fortus, D. and Ramnarain, U., 2013. South African physical sciences teachers' perceptions of new content in a revised curriculum. *South African Journal of Education*, 33(1), pp. 1 – 15.

Francis, M.M., 2009. *Women in Engineering: Identifying and Analysing Gender Socialisation in the Faculty of Engineering at the University of KwaZulu-Natal*. University of South Africa, Pretoria.

Franzway, S., Gill, J., Mills, J. and Sharp, R., 2008. I still wanna be an engineer! Women, education and the engineering profession. *Journal of Engineering Education,* 33(4), pp. 391 – 402.

Gereffi, G., Ong, R., Rissing, B. and Wadhwa, V., 2008. Getting the Numbers Right: International Engineering Education in the United States, China, and India. *Journal of Engineering Education*, 28(1), pp. 13 – 25.

Greene, J.C., 2007. *Mixed Methods in social inquiry*. San Francisco: Jossey-Bass.

Harris, C.E., Pritchard, M.S. and Rabins, M.J., 2009. *Engineering Ethics. Concepts & Cases*. 4th ed. Canada: Cengage Learning.

Hartman, H. and Harman, M., 2007. How Undergraduate Engineering Students Perceive Women's (and Men's) Problems in Science, Maths and Engineering. *Department of Sociology, Rowan University*, 58, pp. 251 – 265.

Harvard Business Review, 2013. *Women in the Workplace: A Research Roundup*. [Online]. Available: https://hbr.org/2013/09/women-in-the-workplace-a-research-roundup [Accessed 13 May 2016].

Hofstee, E., 2006. *Constructing a Good Dissertation: a Practical Guide to Finishing a Master's MBA or PhD on Schedule*. Johannesburg: EPE.

Holth, L., 2014. Passionate men and rational women: gender contradictions in engineering. *International Journal for Masculinity Studies*, 9(2), pp. 97 – 110.

Hosaka, M., 2010. Learning to become graduate students: Japanese women's experience in the research unit in engineering. *European Journal of Engineering Education*, 35(6), pp. 619 – 626.

Hunt, J., 2015. Why do Women Leave Science and Engineering? *IRL Review*, 69(1), pp. 199 – 226.

Hyde, K.F., 2000. Recognising deductive processes in qualitative research. *Qualitative Market Research: An International Journal*, 3(2), pp. 82 – 90.

Ihsen, S., 2005. Special gender studies for engineering? *European Journal of Engineering Education*, 30(4), pp. 487 – 494.

Ihsen, S. and Buschmeyer, A., 2007. Acting diverse: target group orientation as key competence in engineering education. *European Journal of Engineering Education*, 32(6), pp. 665 – 673.

Institute of Civil Engineering, 2015. *What is Civil Engineering*? [Online]. Available: https://www.ice.org.uk/careers-and-professional-development/what-is-civil-engineer-ing [Accessed 15 April 2016].

Jagacinski, C.M., 2013. Women Engineering Students: Competence Perceptions and Achievement Goals in the Freshman Engineering Course. *Perdue University*, 69, pp. 644 – 657.

Johnson, A.M., Ozogul, G., DiDonato, M.D. and Reisslein, M., 2013. Engineering perceptions of female and male K-12 students: effects of a multimedia overview on elementary, middle-, and high-school students. *European Journal of Engineering Education*, 38(5), pp. 519 – 531.

Johnson, R.B., 2014. *Mixed methods research design and analysis with validity*. Department of Professional Studies, University of South Alabama, USA.

Ka-Mnguni, Z.S., 2009. *Women Engineers Declare War on Shortage of Women in Industry*. Achieve Magazine by MerSETA, 5, pp. 20 – 22.

Kho, Y.H., 2016. Attracting Female Engineering Students: Insights from Malaysia and Kazakhstan. *Global Engineering Education Conference (EDUCON)*, pp. 724 – 728.

Kirton, G. and Healy, G., 2012. 'Lift as you rise': Union women's leadership talk. *Human Relations*, 65(8), pp. 979 – 999.

Kok, K.D., 2009. *Nuclear Engineering Handbook*. London: CRC Press.

Kolari, S., Savander-Ranne, C. and Viskari, E.L., 2006. Do our engineering students spend enough time studying? *European Journal of Engineering Education*, 31(5), pp. 499 – 508.

Kossiakoff, A., Sweet, W.N., Seymour, S.J. and Biemer, S.M., 2011. *Systems Engineering and Practice*. 2nd ed. New Jersey: A John Wiley & Sons, Inc Publications.

Kothari C.R., 2004. *Research Methodology: Methods and Techniques*. 2nd ed. New Delhi: New Age International Publishers.

Krippendorff, K. H., 2012. *Content Analysis: An Introduction to Its Methodology.* 3rd ed. London: SAGE Publications.

Kumar, R., 2011. *Research Methodology. A step-by-step guide for beginners*. 3rd ed. Great Britain: Sage Publications.

Laplante, P.A., 2005. *Comprehensive Dictionary of Electrical Engineering*. 2nd ed. Boca Raton: CRC Press.

Lakens, D., 2013. *Calculating and reporting effect sizes to facilitate cumulative science: a practical primer for t-tests and ANOVAs*. [Online]. Available: http://journal. frontiersin.org/article/10.3389/fpsyg.2013.00863/full [Accessed 6 April 2017].

Leedy, P.D. and Omrod, J.E., 2010. *Practical Research: Planning and Design*. 9th ed. New Jersey: Pearson Education.

Lui, J., Zhong, S. and Zhao, M., 2014. Expected Value-Based Method to Determine the Importance of Engineering Characteristics in QFD with Uncertainty Theory. *Journal of Uncertain Systems*, 8(4), pp. 271 – 284.

Magnell, M., Geschwind, L. and Kolmos, A., 2016. Faculty perspectives on the inclusion of work-related learning in engineering curricula. *European Journal of Engineering Education*, 41(6), pp. 1 – 10.

Male, S.A., Bush, M.B. and Murray, K., 2009. Think engineer, think male? *European Journal of Engineering Education*, 34(5), pp. 455 – 464.

Maree, K., Creswell, J.W., Ebersohn, L., Eloff, I., Ferreira, R., Ivankova, N.V., Jansen, J.D., Nieuwenhuis, J., Pietersen, J., Plano Clark, V.L. and Van der Westhuizen, C., 2012. *First Steps in Research*. 1st ed. Pretoria: Van Schaik.

Mason, J., 2002. *Qualitative Researching*. 2nd ed. London: SAGE Publications.

McKinsey & Company, 2015. *Women in the Workplace*. [Online]. Available: http://womenintheworkplace.com/ [Accessed 31 March 2016].

McKinsey & Company, 2016. *Key persistent areas to address*. McKinsey & Company report: Women matter 2016.

McLeroy, K.R. and Steckler, A., 2008. The Importance of External Validity. *American Journal of Public Health*, 98(1), pp. 9 – 10.

Mcniff, J. and Whitehead, J., 2010. *You and Your Action Research Project*. 3rd ed. Canada: Routledge.

Mills, J.E., 2011. Reflections on the Past, Present and Future of Women in Engineering. *Australasian Journal of Engineering Education*, 17(3), pp. 139 – 146.

Moodley, S., 2014. *Poor maths, science education at heart of SA's skills problems*. [Online]. Available: http://www.engineeringnews.co.za/article/sa-industries-strug-gling-with-skills-shortage-owing-to-poor-math-science-education-2014-06-27 [Accessed 30 April 2016].

Morgan, G. and Smircich, L., 1980. The Case for Qualitative Research. *Academy of Management Review*, 5(4), pp. 491 – 500.

Mtshali, N., 2013. *Only 15 % of SA university students graduate*. [Online]. Available: http://www.iol.co.za/lifestyle/family/kids/only-15-of-sa-university-students-graduate-1531809 [Accessed 6 May 2016].

Neuman, W.L., 2006. *Social Research Methods: Qualitative and Quantitative Approaches.* 6th ed. Pearson.

Nunnally, J.C., 1978. *Psychometric Theory*. 2nd ed. New York: McGraw-Hill.

Organisation for Economic Co-operation and Development (OECD), 2015. *Education and employment – what are the gender differences*? Education Indicators in Focus.

Oxbridge Academy, 2015. *Top 5 Careers in Engineering*. [Online]. http://blog.oxbridgeacademy.co.za/top-5-careers-in-engineering [Accessed 6 May 2016.]

Perez, E., 2011. *Female Engineering majors struggle with confidence issues*. [Online]. Available: http://californiawatch.org/dailyreport/female-engineering-majors-struggle-confidence-issues-13307 [Accessed 19 June 2015].

Queen's University, 2016. *Types of Engineering*. [Online]. Available: http://www.aboriginalaccess.ca/adults/types-of-engineering [Accessed 4 April 2016].

Quinn, T.J., Dawson, J., Walters, M.R. and Lees, K. R., 2009. Reliability of the Modified Rankin Scale: A Systematic Review. *Journal of the American Heart Association*, 4(1), pp. 1 – 4.

Rasoal, C., Danielsson, H. and Jungert, T., 2012. Empathy among students in engineering programmes. *European Journal of Engineering Education*, 37(5), pp. 427 – 435.

Saunders, M., Lewis, P. and Thornhill, A., 2009. *Research Methods for Business Students.* 5th ed. Harlow: Pearson Education.

Saunders, M., Lewis, P. and Thornhill, A., 2012. *Research Methods for Business Students.* 6th ed. Harlow: Pearson Education.

Saunders, M. and Tosey, P., 2013. The Layers of Research Design. pp. 58-59.

Schäfer, A.I., 2006. A new approach to increasing diversity in engineering at the example of women in engineering. *Journal of Engineering Education,* 31(6), pp. 661 – 671.

Schreuders, P.D., Mannon, S.E. and Rutherford, B., 2009. Pipeline or personal preference: women in engineering. *European Journal of Engineering Education*, 34(1), pp. 97 – 112.

Seggie, E., 2014. *SA's engineering shortage widens*. [Online]. Available: http:// www. moneyweb. co.za/ archive/ sas-engineering-shortage-widens/ [Accessed 26 June 2015].

Shuttleworth, M., 2009. *Definition of Reliability*. [Online]. Available: https://explorable.com/definition-of-reliability [Accessed 26 July 2015].

Sinha, K., 2015. *India set to produce world's largest number of engineers*. [Online]. Available: http://timesofindia.indiatimes.com/india/India-set-to-produce-worlds-largest-number-of-engineers/articleshow/49532113.cms [Accessed 14 April 2016].

Smeding, A., 2012. Women in Science, Technology, Engineering, and Mathematics (STEM): An Investigation of Their Implicit Gender Stereotypes and Stereotypes' Connectedness to Math Performance. *Sex Roles*, 67(11), pp. 617 – 629.

Stonyer, H., 2002. Making Engineering Students – Making Women: The Discursive Context of Engineering Education*, Auckland University of Technology,* 18(1), pp. 392 – 399.

Thompson, M., 2015. *Women engineers quit over men's attitudes*. [Online]. Available: http://mg.co.za/article/2015-08-22-women-engineers-quit-over-mens-attitudes/ [Accessed 6 May 2016].

Trochim, W.M., 2006. *Deduction & Induction*. [Online]. Available: http://www. social researchmethods.net/kb/dedind.php [Accessed 18 August 2016].

University of Washington, 2014. *What is Mechanical Engineering*? [Online]. Available: https://www.me.washington.edu/prospective/whatisme.html [Accessed 15 April 2016].

Voinov, V., Nikulin, M. and Balakrishnan, N., 2013. *Chi-squared Goodness of Fit Tests with Application*. Waltham: Elsevier.

Watkins, S.A., 2011. *An Evaluation of the Factors Affecting Student Success at a South African Higher Education Institution: Implications for Management*. Nelson Mandela Metropolitan University, Port Elizabeth.

Wegner, T., 2012. *Applied Business Statistics: Methods and Excel-based Applications.* 3rd ed. Cape Town: JUTA Academic.

World Economic Forum, 2015. *SA bottom of global maths and science*. [Online]. Available: http://businesstech.co.za/news/general/85021/sa-bottom-of-global-maths-and-science-list/ [Accessed 27 April 2016].

World Economic Forum, 2015. *Which country has the most engineering graduates?* [Online]. Available: https://www.weforum.org/agenda/2015/09/which-country-most-engineering-manufacturing-and-construction-graduates/ [Accessed 14 April 2016].

Wright, J., 2014. *The Most In-Demand (And Aging) Engineering Jobs*. [Online]. Available: http://www.forbes.com/sites/emsi/2014/09/12/the-most-in-demand-and-oldest-engineering-jobs/#1ba2506b4b4a [Accessed 20 April 2016].

Writer, S., 2015a. *Best university in South Africa to study technology and engineering*. [Online]. Available: http://mybroadband.co.za/news/general/138632-best-university-in-south-africa-to-study-technology-and-engineering.html [Accessed 7 May 2016].

Writer, S., 2015b. *Shocking number of engineering dropouts at SA universities*. [Online]. Available: http://businesstech.co.za/news/government/101122/shocking-number-of-engineering-dropouts-at-sa-universities/ [Accessed 6 May 2016].

Wyse, S.E., 2012. *Advantages and Disadvantages of Surveys*. [Online]. http://www.snapsurveys.com/blog/advantages-disadvantages-surveys/ [Accessed 3 September 2016].

Yilmaz, K., 2013. Comparison of Quantitative and Qualitative Research Traditions: epistemological, theoretical, and methodological differences. *European Journal of Education,* 48(2), pp. 311-325.

Yin, R.K., 2009. *Case Study Research. Design and Methods*. 5th ed. Los Angeles: SAGE Publications.

Zikmund, W.G., Babin, B.J., Carr, J.C. and Friffin, M., 2010. *Business Research Methods*. 8th ed. Canada: South-Western.

Appendix A – RESEARCH ALIGNMENT PLAN

Title: Factors affecting Female Students studying Engineering at a Higher Education Institution				
Research Problem: There is a major shortage of engineers, especially women choosing Engineering as a career.				
Main Research Objective: To determine the factors that is affecting female students while studying towards a field in Engineering at a Higher Education Institution.				
Main Research Question (RQ_M): What are the effective attractions of female students studying towards a field in Engineering?				
Secondary Research Questions		**Research Objectives**	**Chapters**	**Deliverables**
RQ_1 **RQ_2**	Why do male and female students choose a career in engineering? What challenges do female students encounter while studying engineering?	RO_1 - Identify why males and females choose a career in Engineering RO_2 - Identify the challenges what female students encounter while studying engineering.	Chapter 2 - **ENGINEERING** (Literature Study)	**Identified why both genders choose engineering and challenges female students encountered while studying Engineering**
RQ_3	What research methodology can be used for this study?	RO_3 - Identify the research methodology applied in this research study.	Chapter 3 - **RESEARCH DESIGN AND METHODOLOGY** (Literature Study)	
RQ_4 **RQ_5**	What are the significant differences between male and female students for choosing a career in engineering? What are the challenges that female students encounter while studying engineering?	RO_4 - Identify the significant differences between males and female students for choosing a career in engineering. RO_5 - Identify the challenges that female students encounter while studying engineering.	Chapter 4 - **RESULTS AND ANALYSIS OF THE FACULTY OF ENGINEERING SURVEY** (Empirical Study)	**Comprehensive analysis of the collected empirical data.**
RQ_M	What attracts female students studying towards a field in Engineering?	RO_M	Chapter 5 - **FINDINGS, RECOMMENDATIONS AND CONCLUSIONS**	**Results**

Appendix B – ETHICAL CLEARANCE FORM E WITH RESOLUTION NUMBER

• PO Box 77000 • Nelson Mandela Metropolitan University
• Port Elizabeth • 6031 • South Africa • www.nmmu.ac.za

Nelson Mandela Metropolitan University
for tomorrow

Chairperson: Research Ethics Committee (Human)
Tel: +27 (0)41 504-2235

Ref: [H16-BES-BUS-022/Approval]

Contact person: Mrs U Spies

17 November 2016

Prof M Cullen
Faculty: BES
2nd Avenue Campus

Dear Prof Cullen

FACTORS AFFECTING FEMALE STUDENTS STUDYING ENGINEERING AT A HIGHER EDUCATION INSTITUTION

PRP: Prof M Cullen
PI: Ms H Boshoff

Your above-entitled application served at Research Ethics Committee (Human) for approval.

The ethics clearance reference number is **H16-BES-BUS-022** and is valid for three years. Please inform the REC-H, via your faculty representative, if any changes (particularly in the methodology) occur during this time. An annual affirmation to the effect that the protocols in use are still those for which approval was granted, will be required from you. You will be reminded timeously of this responsibility, and will receive the necessary documentation well in advance of any deadline.

We wish you well with the project. Please inform your co-investigators of the outcome, and convey our best wishes.

Yours sincerely

Prof C Cilliers
Chairperson: Research Ethics Committee (Human)

cc: Department of Research Capacity Development
Faculty Officer: BES

Appendix C – ENGINEERING DISTRIBUTION EMAIL

From: Hildegarde.Boshoff@mandela.ac.za
Sent: 25 November 2016 08:17 AM
To: * ENGINEERING STUDENTS
Subject: #SURVEYS - Engineering Survey

REC-H Reference Number: H16-BES-BUS-022

Dear Engineering Student

You are invited to participate in a research study: "**Factors affecting Female Students studying Engineering at a Higher Education Institution**". The study will require you to complete a questionnaire related to your experience while studying an engineering related qualification at Nelson Mandela University. The completion of this survey is done on a voluntary basis. Completion and submission of the survey will constitute consent for the data to be used in the study. None of your personal information will be used or published in the study or in any scientific articles published. Participation in this study will not result in any additional cost to you. If at any stage you wish to remove yourself from the study, you may opt-out and your information will remain confidential.

The investigators are researching the experience of male and female students while studying engineering, in order to gain a better understanding of the current experience of engineering students. The data collected will assist the researcher to analyses the gaps between male and female students' experiences and especially to assist female students in a male-dominant environment. This information will be used for research academic purposes only.

You, as the participant, will be required to answer a series of questions related to your experience while studying at NMMU. The expected time to complete this survey is 20 minutes.

Please click on the link below to access the survey:

http://www.questionpro.com/t/AMbHzZXtJP

Kind Regards

Hildegarde Boshoff

Faculty Administrator
Faculty of Engineering, the Built Environment and Information Technology
Faculty Administration Section
Department of Academic Administration
Block C - Room 112
Tel: 041 504 3446
Fax: 041 504 9871

Appendix D – QUESTIONNAIRE

NELSON MANDELA UNIVERSITY

ENGINEERING SURVEY

Please place a tick next to selection. One tick per question. Complete all questions.

Section 1: Demographic Data

1.1	Gender	**Male**	
		Female	

1.2	Age	**18 - 20**	**21 - 23**	**24 - 26**	**27 +**

1.3	What ethnic group do you belong to?	**Asian**	**Black**	**Coloured**
		Indian	**White**	**Other**
		Specify if other:		

1.4	What is your home language?	**Afrikaans**	**English**	**Xhosa**	**Zulu**	**Other**
		Specify if other:				

1.5	Which province are you from? Please specify country if outside of South Africa.	**Eastern Cape**	**Free State**	**Gauteng**	**KwaZulu-Natal**	**Limpopo**
		Mpumalanga	**Northern Cape**	**North West**	**Western Cape**	**Other**
		Specify if other:				

1.6	What qualification are you enrolled for?	**Civil Engineering**	**Electrical Engineering**	**Industrial Engineering**	**Mechanical Engineering**	**Mechatronics**

1.7	What year of study are you in?	**First Year**	**Second Year**	**Third Year**	**Fourth Year**

-	Was Nelson Mandela University your first choice of university to study engineering?	**Yes**	**No**

1.9	If 'no' to question 1.8, which was your first university, you applied to?	

Section 2: Before Starting with Engineering Studies

2.1	When did you first develop an interest in Engineering?	**Ages 3 – 6**	**Ages 7 –12**	**Ages 13 –18**	**Can't remember**

2.2	Why did you choose to study engineering? Please tick all relevant boxes.	**Always wanted to be an engineer**	
		Parents influence	
		Peer influence	
		Want to make money	
		Saw an advert	
		Variety of career opportunities	
		Enjoy problem-solving activities	
		Enjoy designing and creating activities	
		I do not know why	
		Other	
		Specify if other:	

2.3	What/Who triggered your interest in Engineering as a career? Please tick all relevant boxes.	**Educator**	
		Parent/Guardian	
		Friends	
		Guidance Counsellor	
		University Marketing Days	
		University Staff	
		A qualified Engineer	
		The Media	
		Television/ Movies	
		Cannot remember	
		Other	
		Specify if other:	

2.4	Did you participate in any of the following **science, math, or engineering** experiences during high school?	**Summer science, math, or engineering programmes**	Yes	No
		Competitions or contests	Yes	No
		After-school clubs	Yes	No
		Special programmes or workshops (on weekends, after-school)	Yes	No
		Teaching science, math, or engineering to others	Yes	No
		Research experience	Yes	No
		Paid work experience in science, math, or engineering	Yes	No
		Volunteer work experience	Yes	No

Section 3: Experience During your Engineering Studies

3.1	During your studies have you ever taken a leave of absence?	**Yes**	**No**

3.2	What do you enjoy <u>most</u> about studying engineering?

3.3	What do you enjoy <u>least</u> about studying engineering?

Please tick the appropriate box with each statement. Complete all questions.

3.4	**Since you entered the university, how has your self-confidence changed in:**					
		Greatly Decreased	**Slightly Decreased**	**Stayed the Same**	**Slightly Increased**	**Greatly Decreased**
3.4.1	Your math abilities	1	2	3	4	5
3.4.2	Your science abilities	1	2	3	4	5
3.4.3	Your engineering abilities	1	2	3	4	5
3.4.4	Your overall academic abilities	1	2	3	4	5

3.5	**In your engineering courses, how often:**					
		Never	**Almost Never**	**Sometimes**	**Almost Always**	**Always**
3.5.1	Do you fail to do your best work?	1	2	3	4	5
3.5.2	Do you turn in completed assignments on time?	1	2	3	4	5
3.5.3	Do you seek ways to improve a design or project, even after it's been in?	1	2	3	4	5
3.5.4	Do you take initiative in your learning process?	1	2	3	4	5
3.5.5	When working in teams, did you complete your part of the task on time?	1	2	3	4	5
3.5.6	Are you dependable?	1	2	3	4	5

3.6	To what extent do you agree with the following statements?					
		Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
3.6.1	I have a high level of interest in engineering.	1	2	3	4	5
3.6.2	I feel there is a lot of competition (among students) in the engineering department.	1	2	3	4	5
3.6.3	I feel confident that I could find a job in engineering that pays well.	1	2	3	4	5
3.6.4	I am overwhelmed by the workload in my engineering courses.	1	2	3	4	5
3.6.5	I am happy with my choice of engineering.	1	2	3	4	5
3.6.6	I am committed to complete my engineering qualification.	1	2	3	4	5

3.7	**Compared to WOMEN in your engineering courses** how would you complete the following:					
		Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
3.7.1	I spend more time and effort on my classwork.	1	2	3	4	5
3.7.2	I understand engineering concepts better.	1	2	3	4	5
3.7.3	I am better at solving engineering problems.	1	2	3	4	5
3.7.4	I am more committed to engineering.	1	2	3	4	5
3.7.5	I work better with other people.	1	2	3	4	5
3.7.6	I have more confidence in my engineering abilities.	1	2	3	4	5
3.7.7	I have developed better analytical skills.	1	2	3	4	5

3.8	**Compared to MEN in your engineering courses**, how would you complete the following:					
		Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
3.7.1	I spend more time and effort on my classwork.	1	2	3	4	5
3.7.2	I understand engineering concepts better.	1	2	3	4	5
3.7.3	I am better at solving engineering problems.	1	2	3	4	5
3.7.4	I am more committed to engineering.	1	2	3	4	5
3.7.5	I work better with other people.	1	2	3	4	5
3.7.6	I have more confidence in my engineering abilities.	1	2	3	4	5
3.7.7	I have developed better analytical skills.	1	2	3	4	5

Section 4: Most Influential People During Studies

4.1 **For each of the following people, how much encouragement or discouragement did you receive about pursuing a diploma or degree in engineering? (If not applicable, choose N/A.)**

		Great deal of Discouragement	A little Discouragement	Neither Encouraged/ Discouraged	A little Encouragement	Great deal of Encouragement	N/A
4.1.1	Mother	1	2	3	4	5	6
4.1.2	Father	1	2	3	4	5	6
4.1.3	Most influential sibling(s)	1	2	3	4	5	6
4.1.4	Most influential high school peers	1	2	3	4	5	6
4.1.5	Most influential teacher	1	2	3	4	5	6
4.1.6	High school guidance counsellor	1	2	3	4	5	6
4.1.7	Someone who works in a science/math/ engineering field.	1	2	3	4	5	6
4.1.8	Most influential university engineering faculty member	1	2	3	4	5	6
4.1.9	University advisor	1	2	3	4	5	6
4.1.10	Most influential graduate student or teaching assistant	1	2	3	4	5	6
4.1.11	Most influential peers in engineering	1	2	3	4	5	6

4.2 **For each of the following people, how much encouragement or discouragement did you receive about pursuing a diploma or degree in engineering? (If not applicable, choose N/A.)**

		Great deal of Discouragement	A little Discouragement	Neither Encouraged/ Discouraged	A little Encouragement	Great deal of Encouragement	N/A
4.2.1	Employment opportunities	1	2	3	4	5	6
4.2.2	Salary potential	1	2	3	4	5	6
4.2.3	Interest in the subject matter in engineering	1	2	3	4	5	6
4.2.4	Quality of teaching in engineering	1	2	3	4	5	6
4.2.5	Mentor	1	2	3	4	5	6
4.2.6	Study group	1	2	3	4	5	6
4.2.7	Your grades	1	2	3	4	5	6
4.2.8	Your spouse/Partner	1	2	3	4	5	6
4.2.9	Your peers	1	2	3	4	5	6

4.2.10	Internship/Research experience	1	2	3	4	5	6
4.2.11	Amount of time required for engineering coursework	1	2	3	4	5	6
4.2.12	Competition in engineering classes	1	2	3	4	5	6
4.2.13	Pace of engineering courses	1	2	3	4	5	6
4.2.14	Number of women in the faculty of engineering	1	2	3	4	5	6
4.2.15	Class size in engineering	1	2	3	4	5	6
4.2.16	Atmosphere of engineering department/courses	1	2	3	4	5	6

4.3	**To date, which was your single, most significant source of <u>encouragement</u>? (Only choose one.)**		
4.3.1		**Mother**	
		Father	
		Sibling	
		Spouse/Partner	
		High School peers	
		Precollege teacher	
		High School guidance counsellor	
		Someone who works in a science/math/engineering field.	
		University Faculty Member	
		Graduate student or teaching assistant	
		University peers	
		Employment opportunities	
		Salary potential	
		Interest in the subject matter in engineering	
		Quality of teaching in engineering	
		Study group	
		Grades	
		Internship/Research experience	
		Amount of time required for engineering coursework	
		Competition in engineering classes	
		Pace of engineering courses	
		Number of women in Engineering Faculty	
		Class size in engineering	
		Atmosphere of engineering department/ courses	

4.4	**To date, which was your single, most significant source of <u>discouragement</u>? (Only choose one.)**		
4.4.1		**Mother**	
		Father	
		Sibling	
		Spouse/Partner	
		High School peers	
		Precollege teacher	
		High School guidance counsellor	
		Someone who works in a science/math/engineering field.	
		University Faculty Member	

		Graduate student or teaching assistant	
		University peers	
		Employment opportunities	
		Salary potential	
		Interest in the subject matter in engineering	
		Quality of teaching in engineering	
		Study group	
		Grades	
		Internship/Research experience	
		Amount of time required for engineering coursework	
		Competition in engineering classes	
		Pace of engineering courses	
		Number of women in Engineering Faculty	
		Class size in engineering	
		Atmosphere of engineering department/ courses	

4.5	**Reflecting on your experiences during the last year in which you studied engineering, to what extent do you agree or disagree with the following statements?**					
		Strongly Disagree	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**
4.5.1	The content of my engineering courses was less relevant to women than men.	1	2	3	4	5
4.5.2	During my engineering classes, my lecturers made comments that demeaned women.	1	2	3	4	5
4.5.3	As an engineering student, I felt stigmatised by students outside engineering.	1	2	3	4	5
4.5.4	My engineering department was supportive of women students.	1	2	3	4	5
4.5.5	I felt more comfortable in my classes in departments outside of engineering than in my engineering classes.	1	2	3	4	5
4.5.6	The competitive climate in engineering favoured male students.	1	2	3	4	5
4.5.7	I believe that engineering departments should have special programmes to address women's needs.	1	2	3	4	5
4.5.8	I believe it is easier for women to go into some fields of engineering than other fields.	1	2	3	4	5
4.5.9	Being a woman improves my prospects of finding a job in engineering.	1	2	3	4	5
4.5.10	I believe women are generally offered higher-paying jobs in engineering than men.	1	2	3	4	5
4.5.11	It is more difficult for a woman to balance a family and career in engineering than in most other fields.	1	2	3	4	5
4.5.12	I would encourage other women to study engineering	1	2	3	4	5

4.6	During the last year in which you studied engineering, how frequently did you participate in any of the following on your campus?					
		Once a week	1 – 3 times a month	1 – 3 times a semester	Once a year	Never
4.6.1	Study or support group	1	2	3	4	5
4.6.2	Internship/ Research experience	1	2	3	4	5
4.6.3	Received tutoring	1	2	3	4	5
4.6.4	Received academic advising	1	2	3	4	5
4.6.5	Received career counselling	1	2	3	4	5
4.6.6	Received peer mentoring	1	2	3	4	5
4.6.7	Participated in online mentoring with a professional engineer	1	2	3	4	5
4.6.8	Been a mentor or “buddy”	1	2	3	4	5
4.6.9	Been a tutor	1	2	3	4	5
4.6.10	Read engineering newsletter	1	2	3	4	5
4.6.11	Engineering society activities	1	2	3	4	5
4.6.12	Engineering speaker	1	2	3	4	5
4.6.13	Field trip to industry site	1	2	3	4	5
4.6.14	Engineering social event	1	2	3	4	5
4.6.15	Worked with outreach to high school students	1	2	3	4	5

4.7	For each activity, which of the following reasons describe why you chose to participate in a study or support group? Please tick all relevant boxes.	**Socialising with other women in engineering**	
		Socialising with men in engineering	
		Getting advice or mentoring about engineering	
		Talking about issues of concern in engineering	
		Getting help with engineering modules	
		Helping others	
		Getting career counselling or information	
		Learning about a topic of interest related to engineering	
		Being in a supportive atmosphere	
		Learning more about specific fields in engineering	

		Getting to know the faculty in engineering	
		Earning money	
		Other	
		Specify if other:	

Section 5: Faculty Related Questions

5.1	**To what extent do you agree or disagree with the following statements?**					
		Strongly Disagree	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**
5.1.1	The number of female lecturers within the Faculty is sufficient	1	2	3	4	5
5.1.2	The School/Faculty provides enough opportunities for social contact with lecturers	1	2	3	4	5
5.1.3	I am exposed to the research undertaken by Postgraduates	1	2	3	4	5
5.1.4	The Faculty should offer male-only and female-only tutorials	1	2	3	4	5
5.1.5	Female students perform better than male students in their specific qualifications	1	2	3	4	5
5.1.6	The School/Faculty provides enough opportunities for social contact with Postgraduates	1	2	3	4	5
5.1.7	Male students dominate discussions in the laboratories/workshops	1	2	3	4	5
5.1.8	Male students are offered more opportunities to pursue postgraduate studies compared to female students	1	2	3	4	5
5.1.9	Female students are unable to cope with the workload in the workshops/laboratories	1	2	3	4	5
5.1.10	The School/Faculty provides good access to research opportunities	1	2	3	4	5
5.1.11	Gender differences do not hinder the learning process	1	2	3	4	5
5.1.12	Lecturers prefer teaching male students	1	2	3	4	5
5.1.13	Male students dominate discussions in class	1	2	3	4	5
5.1.14	Academic staff discriminate against female students	1	2	3	4	5
5.1.15	Gender bias exists in the Academic and Administration of the Faculty	1	2	3	4	5

5.2	The following questions relate to your views on the university's feedback system:					
		Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
5.2.1	I am aware that my institution makes use of access testing (for students who might not meet direct entry requirements)	1	2	3	4	5
5.2.2	I regularly obtain feedback from my lecturers about my academic performance	1	2	3	4	5
5.2.3	I feel that my lecturers are approachable	1	2	3	4	5
5.2.4	At the end of a module I have the opportunity to provide feedback of the module	1	2	3	4	5
5.2.5	I feel that my lecturers are flexible in their teaching practices	1	2	3	4	5
5.2.6	I have been referred to support services (such as student counselling) when I have not done well in a module	1	2	3	4	5
5.2.7	I feel that my lecturers support my learning	1	2	3	4	5
5.2.8	My lecturers will let me know in the first semester if my progress is not what it should be	1	2	3	4	5
5.2.9	There are regular assessments (such as class tests) where I can monitor my progress	1	2	3	4	5

5.3	Describe your experiences within the Faculty of Engineering during the course of your studies.

5.4	Is there any aspect of your Faculty, with regard to Teaching, that you would like to see changed? If yes, please explain.

5.5	**Will you continue with Postgraduate Studies in Engineering? If yes/no, why?**

Thank you for taking the time to complete the questionnaire. Your input is appreciated.

Appendix E – Factor and Item Descriptions

Factor	Item	Statement
Choice CH1	Sec2.Q1	I always wanted to be an engineer.
CH2	Sec2.Q2	My parents' influence my choice.
CH3	Sec2.Q3	My peer's influence my choice.
CH4	Sec2.Q4	I want to make money.
CH5	Sec2.Q5	I saw an advert regarding engineering.
CH6	Sec2.Q6	There is a variety of career opportunities.
CH7	Sec2.Q7	I enjoy problem-solving activities.
CH8	Sec2.Q8	I enjoy designing and creating activities.
CH9	Sec2.Q9	I do not know why.
CH10	Sec2.Q10	Other reasons.
Interest INT1	Sec2.Q11	An educator triggered my interest.
INT2	Sec2.Q12	A parent/guardian triggered my interest.
INT3	Sec2.Q13	My friends triggered my interest.
INT4	Sec2.Q14	A guidance counsellor triggered my interest.
INT5	Sec2.Q15	The university marketing day triggered my interest.
INT6	Sec2.Q16	Staff at the university triggered my interest.
INT7	Sec2.Q17	A qualified engineer triggered my interest.
INT8	Sec2.Q18	The media triggered my interest.
INT9	Sec2.Q19	Television/movies triggered my interest.
INT10	Sec2.Q20	I cannot remember.
INT11	Sec2.Q21	Other reasons.
Readiness RE1	Sec3.Q1	I have confidence in my math abilities.
RE2	Sec3.Q2	I have confidence in my science abilities.
RE3	Sec3.Q3	I have confidence in my engineering abilities.
RE4	Sec3.Q4	I have confidence in my overall academic activities.
Experience 1 EXP1.1	Sec3.Q5	I have a high level of interest in engineering.
EXP1.2	Sec3.Q6	I feel there is a lot of competition in the engineering department (amongst students).
EXP1.3	Sec3.Q7	I feel confident that I could find a job in engineering that pays well.
EXP1.4	Sec3.Q8	I am overwhelmed by the workload in my engineering courses.
EXP1.5	Sec3.Q9	I am very happy with my choice of engineering.
EXP1.6	Sec3.Q10	I am committed to complete my engineering qualification.
Experience 2 EXP2.1	Sec3.Q11	I spend more time and effort on my classwork.
EXP2.2	Sec3.Q12	I understand engineering concepts better.
EXP2.3	Sec3.Q13	I am better at solving engineering problems.
EXP2.4	Sec3.Q14	I am more committed to engineering.
EXP2.5	Sec3.Q15	I work better with other people.
EXP2.6	Sec3.Q16	I have more confidence in my engineering abilities.
EXP2.7	Sec3.Q17	I have developed better analytical skills.

Encouragement1 ENC1.1	Sec4.Q1	My mother encourages me.
ENC1.2	Sec4.Q2	My father encourages me.
ENC1.3	Sec4.Q3	Most influential sibling(s).
ENC1.4	Sec4.Q4	Encouragement from someone who works in a science/ math/ engineering field.
ENC1.5	Sec4.Q5	Encouragement from a university engineering faculty member.
ENC1.6	Sec4.Q6	Encouragement from peers in engineering.
Encouragement2 ENC2.1	Sec4.Q7	I am encouraged by employment opportunities.
ENC2.2	Sec4.Q8	I am encouraged by the salary potential.
ENC2.3	Sec4.Q9	I am encouraged by interest in the subject matter in engineering.
ENC2.4	Sec4.Q10	I am encouraged by quality of teaching by instructors in engineering.
ENC2.5	Sec4.Q11	I am encouraged by my grades.
ENC2.6	Sec4.Q12	I am encouraged by my spouse/ partner.
ENC2.7	Sec4.Q13	I am encouraged by the amount of time required for engineering coursework.
ENC2.8	Sec4.Q14	I am encouraged by the competition in engineering classes.
ENC2.9	Sec4.Q15	I am encouraged by the pace of engineering courses.
ENC2.10	Sec4.Q16	I am encouraged by the number of women in the faculty of engineering.
ENC2.11	Sec4.Q17	I am encouraged by the class size in engineering.
ENC2.12	Sec4.Q18	I am encouraged by the atmosphere of engineering department/ courses.
Studies STU1	Sec4.Q19	The content of my engineering courses was less relevant to women than men.
STU2	Sec4.Q20	In my engineering lecturers, my instructors made comments that demeaned women.
STU3	Sec4.Q21	I felt stigmatised by student outside engineering.
STU4	Sec4.Q22	My engineering department was supportive of female students.
STU5	Sec4.Q23	I felt more comfortable in classes in departments outside engineering than in my engineering classes.
STU6	Sec4.Q24	The competitive climate in engineering favoured male students.
STU7	Sec4.Q25	I believe that engineering departments should have special programmes to address women's needs.
STU8	Sec4.Q26	I believe it is easier for women to go into fields of engineering than other fields.
STU9	Sec4.Q27	I believe women in engineering are generally offered higher-paying jobs than men.
STU10	Sec4.Q28	It is more difficult for women to balance a career and family in engineering than in most other fields.
STU11	Sec4.Q29	I would encourage other women to study engineering.
Study Group ST.GR1	Sec4.Q30	I enjoy socialising with other women in engineering.

ST.GR2	Sec4.Q31	I enjoy socialising with men in engineering.
ST.GR3	Sec4.Q32	I enjoy getting advice or mentoring about engineering.
ST.GR4	Sec4.Q33	I enjoy talking about issues of concern in engineering.
ST.GR5	Sec4.Q34	I enjoy getting help with engineering modules.
ST.GR6	Sec4.Q35	I enjoy helping others.
ST.GR7	Sec4.Q36	I enjoy getting career counselling or information.
ST.GR8	Sec4.Q37	I enjoy learning about a topic of interest related to engineering.
ST.GR9	Sec4.Q38	I enjoy being in a supportive atmosphere.
ST.GR10	Sec4.Q39	I enjoy learning more about specific fields in engineering.
ST.GR11	Sec4.Q40	I enjoy getting to know the faculty in engineering.
ST.GR12	Sec4.Q41	I enjoy earning extra money.
ST.GR13	Sec4.Q42	Other reasons.
Faculty/ University support FA.SUP1	Sec5.Q1	The number of female lecturers within the Faculty is sufficient.
FA.SUP2	Sec5.Q2	The Faculty provides opportunities for social contact with lecturers.
FA.SUP3	Sec5.Q3	I am exposed to research undertaken by Postgraduates.
FA.SUP4	Sec5.Q4	The Faculty should offer tutorials with male-only and female-only classes.
FA.SUP5	Sec5.Q5	Female students perform better than male students in their specific programmes.
FA.SUP6	Sec5.Q6	The School/Faculty provides opportunities for social contact with Postgraduates.
FAC.SUP7	Sec5.Q7	Male student dominate discussions in the laboratories/ workshops.
FA.SUP8	Sec5.Q8	Male students are offered more opportunities to pursue postgraduate studies than their female counterparts.
FA.SUP9	Sec5.Q9	Female students are unable to cope with the workload in the laboratories/workshops.
FA.SUP10	Sec5.Q10	The School/ Faculty provides good access to research opportunities.
FA.SUP11	Sec5.Q11	Gender differences do not hinder the learning process.
FA.SUP12	Sec5.Q12	Lecturers prefer teaching male students.
FA.SUP13	Sec5.Q13	Male students dominate discussions in class.
FA.SUP14	Sec5.Q14	Academic staff discriminate against female students.
FA.SUP15	Sec5.Q15	Gender bias exists in the academic and administrative of the faculty.
Faculty Feedback FA.FE1	Sec5.Q16	I am aware that my institution makes use of access testing (for students who do not meet direct entry requirements).
FA.FE2	Sec5.Q17	I regularly obtain feedback from my lecturers about my academic performance.
FA.FE3	Sec5.Q18	I feel that my lecturers are approachable.

FA.FE4	Sec5.Q19	At the end of a module, I have the opportunity to provide feedback.
FA.FE5	Sec5.Q20	I feel that my lecturers are flexible in their teaching practices.
FA.FE6	Sec5.Q21	I have been referred to support services (such as student counselling) when I have not done well in a module.
FA.FE7	Sec5.Q22	I feel that my lecturers support my learning.
FA.FE8	Sec5.Q23	My lecturers will let me know in the first semester if my progress is not what is should be.
FA.FE9	Sec5.Q24	There are regular assessments, where I can monitor my progress.

Appendix F – ENGINEERING SURVEY DEMOGRAPHIC INFORMATION

Section 1

1.1 Gender		
Answer	**TOTAL**	
Female	135	45%
Male	168	55%
TOTAL	**303**	**100%**

1.2 Age						
Answer	**Female**		**Male**		**TOTAL**	
18 – 20	47	35%	54	32%	101	33%
21 – 23	48	35%	55	33%	103	34%
24 – 26	21	16%	34	20%	55	18%
27 +	19	14%	25	15%	44	15%
TOTAL	**135**	**100%**	**168**	**100%**	**303**	**100%**

1.3 What ethnic group do you belong to?						
Answer	**Female**		**Male**		**TOTAL**	
Asian	1	1%	1	1%	2	1%
Black	86	64%	83	49%	169	56%
Coloured	22	16%	21	12%	43	14%
Indian	9	7%	8	5%	17	5%
White	15	11%	54	32%	69	23%
Other	2	1%	1	1%	3	1%
TOTAL	**135**	**100%**	**168**	**100%**	**303**	**100%**

1.4 What is your home language?						
Answer	**Female**		**Male**		**TOTAL**	
Afrikaans	13	10%	44	26%	57	19%
English	38	28%	48	29%	86	28%
Xhosa	56	41%	55	33%	111	37%
Zulu	8	6%	7	4%	15	5%

Other	20	15%	14	8%	34	11%
TOTAL	**135**	**100%**	**168**	**100%**	**303**	**100%**

1.5 Which province are you from?						
Answer	**Female**		**Male**		**TOTAL**	
Eastern Cape	84	62%	119	70%	203	67%
Free State	4	3%	3	2%	7	2%
Gauteng	7	5%	9	5%	16	5%
KwaZulu Natal	13	10%	5	3%	18	6%
Limpopo	12	9%	8	5%	20	7%
Mpumalanga	1	1%	3	2%	4	1%
Northern Cape	2	1%	0	0%	2	1%
North West	1	1%	5	3%	6	2%
Western Cape	7	5%	6	4%	13	4%
Other	4	3%	10	6%	14	5%
TOTAL	**135**	**100%**	**168**	**100%**	**303**	**100%**

1.6 What qualification are you enrolled for?						
Answer	**Female**		**Male**		**TOTAL**	
Civil Engineering	36	26%	54	32%	90	30%
Electrical Engineering	25	19%	60	36%	85	28%
Industrial Engineering	38	28%	14	8%	52	17%
Mechanical Engineering	23	17%	28	17%	51	17%
Mechatronics	13	10%	12	7%	25	8%
TOTAL	**135**	**100%**	**168**	**100%**	**303**	**100%**

1.7 What year of study are you in?						
Answer	**Female**		**Male**		**TOTAL**	
First Year	25	19%	54	32%	79	26%

Second Year	41	30%	33	20%	74	24%
Third Year	28	21%	29	17%	57	19%
Fourth Year	41	30%	52	31%	93	31%
TOTAL	**135**	**100%**	**168**	**100%**	**303**	**100%**

1.8 Was Nelson Mandela University your first choice of university to study engineering?						
Answer	**Female**		**Male**		**TOTAL**	
Yes	104	77%	127	76%	231	76%
No	31	23%	41	24%	72	24%
TOTAL	**135**	**100%**	**168**	**100%**	**303**	**100%**

Factor Items

	Mean	S.D.	Greatly Decreased	Slightly Decreased	Stayed the same	Slightly Increased	Greatly Increased
Sec3.Q1	3.82	1.16	14 4.6%	36 11.9%	43 14.2%	109 36.0%	101 33.3%
Sec3.Q2	3.90	0.97	7 2.3%	19 6.2%	59 19.5%	129 42.6%	89 29.4%
Sec3.Q3	4.28	0.87	6 2.0%	10 3.3%	19 6.3%	127 41.9%	141 46.5%
Sec3.Q4	3.95	1.05	6 2.0%	37 12.2%	28 9.2%	126 41.6%	106 35.0%

Table 6.1 - Frequency Distributions: RE1 (n = 303).

Appendix G – TURNITIN