UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

Women academics in engineering: reasons for commitment to the field

by

Yeukai Angela Mlambo

A mini-dissertation submitted in partial fulfilment of the requirements for the degree

MA Research Psychology

in the Department of Psychology at the

UNIVERSITY OF PRETORIA

FACULTY OF HUMANITIES

SUPERVISOR: Professor Cheryl. M. De la Rey

August, 2011

Acknowledgements

I would like to acknowledge the following people for their contributions and support:

- The women who shared their stories with me, for being open and willing to participate in the study.
- My supervisor Professor C.M. De la Rey, for your guidance.
- Ingrid Lynch, for always being there for me to bounce ideas off of and for your input on draft chapters and your encouragement and support throughout the research process.
- My father Professor Alois Mlambo, for your guidance and editing of all my work and for your encouragement and support.
- My mother Rosemary Mlambo, you have been my greatest pillar of support throughout my studies and in life.
- Dr. S. Boshoff for encouragement and for reading through and editing my work
- My siblings, Brian and Chipo Mlambo, for your patience and support.
- To my family and friends, especially Fatima Kurtha, for being there on the difficult days, always urging me along.

Abstract

This study aims to investigate the reasons women in engineering academia provide for their continued presence in the field. A review of the literature shows that the underrepresentation of women in engineering is an issue of concern for policy makers in both public and private sectors. Engineering is a male domain, with very few women present in the field. While research has focused on the reasons for women's underrepresentation in engineering, little research has focused on understanding why women who are already in the field remain committed to it. Using feminist standpoint theory and a qualitative methodology, this study explored the reasons women in engineering academia attribute their commitment to the field to. Interviews were conducted with nine women in academic engineering who participated in the study. All of the participants were White South Africans whose ages ranged between 22-45 years old, with an average participant age of 34 years. The participants had participated in academia from between 1-14 years, with an average participation in academia of 4 years. All participants had some form of experience in industry. Thematic analyses of the interviews conducted with the women revealed four main themes and a number of sub-themes. The themes were related to the reasons for entering and staying in academia and the challenges women face in the workplace and how these women deal with them. The study contributes to the research on women in engineering, in academia and women in engineering in South Africa.

Keywords: women in engineering, women in academia, feminist standpoint theory, thematic analysis

Table of contents

"Every aspect of our lives is touched by socio-technical systems and unless women are in the engine-rooms of technological production, we cannot get our hands on the level of power. The movement of more women in scientific and technological policy education and so on, may bring significant advances in redesigning technology. It would also both require and constitute a challenge to the male culture of technology"

(Wajcman, 2004, p. 111)

Chapter 1: Introduction

1.1 Introduction

The problem of the underrepresentation of women in engineering is recognised by many authors and by those responsible for formulating policy. Most research on women in engineering has been on the reasons why women are in low numbers in this field, with the different challenges and obstacles women face being the main focus. There is limited research on the reasons that women remain in the field of engineering despite these challenges. Therefore, this mini-dissertation focused on gaining an understanding of the reasons women academics in engineering provide for their continued presence in the field.

This study included a review of the literature available on women in engineering in order to show the contribution the research makes to knowledge in this area. This chapter provides an overview of the study.

1.2 Research problem

The problem of the underrepresentation of women in science, engineering and technology has been featured in institutional policy debates in South Africa and the rest of the world due to a recognition that women's occupation of senior roles in engineering was and continues to be unacceptably low (Davis, 2001; Garforth & Kerr, 2009; Glover, 2001; Monhardt, Tillotson & Veronesi, 1999; Rosser & Taylor, 2009). Male-dominated social structures within the engineering community have limited and excluded the participation of women (Davis, 2001).

In South Africa, the proportion of women to men in all engineering professions decreased from 11.7% to 8.64% from 1996 to 2005 (Du Toit & Roodt, 2009). In 2009, one year prior to the country hosting the World Cup, South Africa had only 473 engineers per million citizens, as compared to Japan and Korea before they hosted the same event in 2002, where there were 3 306 engineers per million citizens (Du Toit & Roodt, 2009). There are approximately 40 women engineers per million citizens in South Africa, which is not a true reflection of the

larger numbers of females in tertiary institutions who enrol for engineering courses every year (Du Toit & Roodt, 2009). Between the years 2006 to 2008, female enrolment in SET related fields steadily increased from 43.5% to 43.7%, with women occupying about 25% of enrolments in engineering and engineering technology fields in 2008 (Small Business Project, 2011). In 2004, women occupied only 9% of academic staff positions in engineering departments in South African universities (Maree, & Maree, 2007). These numbers are evidence not only of the low number of engineers in the country, but also suggest the need to tap into the country's women population as a useful and capable resource to increase the number of engineers in the country.

In the meantime, the need to focus on the retention of those women already in the field is acknowledged, by policy makers, as an issue requiring attention. However, there is as yet no analysis of the factors which account for the women who continue to remain committed to the field of engineering despite the challenges and obstacles they are documented as facing (Gupta & Sharma, 2003). Understanding the experiences of the women who are in engineering and how they account for their continued commitment to the field will help provide information that may assist in facilitating the retention of more women in the field of engineering and may contribute to addressing the problem of women's underrepresentation in engineering.

1.2.1 Clarification of terms

A few operational definitions of the terms used in the study need clarification. First, **women in engineering** in this dissertation refers to the population of women in the engineering profession. This research focuses on the accounts of women academics in engineering. The terms 'women in engineering' and 'women academics in engineering' will be used interchangeably to refer to individuals of the female sex and gender who are currently members of the academic staff in the School of Engineering at the University of Pretoria who also form part of the larger group of women in engineering. Second, **commitment** is operationally defined as the assumed decision by the women under study to continue in an academic career in engineering, based on their current position in an academic and tertiary education institution. Third, the term **account** will be used to refer to the description as revealed in the experiences provided that highlight the factors/attributions, personal, social or otherwise, that are provided by the participants as being an explanation for the continued presence of the participants in the field of engineering (Nauta, Epperson & Waggoner, 1999).

1.2.2 Research Question

The study explored first-hand accounts of the experiences of women in engineering as they relate to their continued presence in the field of engineering. It attempts to answer the question: *How do women in engineering account for their continued commitment to and presence in the field of engineering?*

1.3 Aims and objectives

In answering the research question, the study explored the ideas, feelings and experiences relating to the position and status of women in engineering as they help to provide insight into the factors or reasons, personal or otherwise, that contribute to the continuous commitment of women to the field of engineering. It attempted to highlight the impact of social gender expectations and roles on the position and status of women in the field of engineering. The guiding assumption from which the study evolved, among others, is that gender categories will always be present in determining the role and representation of women in any arena. Gender categorization also plays a part in how women experience and cope with the challenges and obstacles they may face in the field (Finchilescu, 2006). In addition to this, the study also tried to highlight the different reasons given for the continued existence and commitment of women academic engineers to the field of engineering. These reasons are then interpreted as they relate to the challenges and obstacles revealed in numerous studies and as revealed in the current study.

This study contributes to knowledge on women in engineering, with the intention of contributing to the search for strategies designed to retain more women in the field.

1.4 Justification/motivation

In a study on 'policy issues relating to women's representation in professional scientific employment', Glover (2001) asks: "What it is about scientific institutions [and] culture...that turn qualified women away?" (p. 79). This study aimed to understand what it is that keeps women committed to engineering, given the assumption that the institutional culture keeps women away. In attempting to understand what has led to women's underrepresentation in engineering careers, the role of the organizational system of the field may be significant (Garforth & Kerr, 2009). It has been suggested, for instance, that women in engineering academia and in the non-academic workplace are subject to masculine cultural values that require them to adjust to the culture in order to be able to function optimally (Gupta & Sharma, 2003). Tertiary institutional culture is described as being patriarchal in nature

(Maree, & Maree, 2007), with the Engineering Faculty culture being more visible in its value of masculine characteristics over femininity and this impacts on the recruitment and retention of women in engineering. While recruitment of women into fields of science and engineering is important, there may be a need to change the working environments which engineers are exposed to. Greater transparency in organizational processes of recruitment, evaluation and reward can go a long way to increase women's confidence in their ability to equally contribute to a rather male-dominated sector (Garforth & Kerr, 2009). In light of the above, an exploration of what reasons women academics in engineering provide for their continued commitment to the field of engineering can provide an understanding of the different challenges women in this field face and how those who are presently in engineering cope with the challenges.

According to Cronin and Roger (1999) although many initiatives have been established in order to address women's underrepresentation in engineering in institutions of higher education, such as public information and outreach programs and mentoring programs (Dryburgh, 1999; Garforth & Kerr, 2009; Pawley, 2004), the presence of women in engineering remains significantly minuscule (Dryburgh, 1999). They argue that the problem is not in attracting women into the field, as has been previously assumed, rather, the problem lies in keeping women in the system, as most women eventually opt out of scientific fields as time goes on. Cronin and Roger (1999) identify some reasons women have given for choosing not to continue in engineering. Among these was the masculine image of the engineering field, which does not resonate with most women (Cech, 2007; Maree & Maree, 2007; Monhardt et al., 1999). Apart from the fact that they often prioritise the need to look after their families over their careers, women have also identified the negative attitudes they experience from their male peers and the stress associated with being a minority group within academic departments as major impediments (Cronin & Roger, 1999).

According to Cech (2007) deterrents for women engineers emerge when there is tension between the normative gender expectations associated with being a woman and the cultural understandings of what is culturally conceived as being an engineer, that is, a masculine occupational expectation. The masculine ideal, which is often associated with rationality, objectivity and the ability to be technologically focused, as opposed to people-sensitive characteristics and is then used as a yardstick to measure women's operations in engineering, and the inevitable risk of falling short deter women from pursuing an engineering career. Thus, cultural expectations also play a role in women's participation in engineering (Cech, 2007). Clearly, therefore, gender and cultural categories play a role in

determining the experiences of women. They also play a role in the manner in which women cope with or overcome challenges faced within their academic or career paths within the field of engineering.

The challenges and obstacles faced by women in engineering have been extensively analysed (Coetzee, 2001; Davis, 2001; Good, Aronson & Harder, 2008; Monhardt et al., 1999; Moore, 2006; Pawley, 2004). What had not yet been examined are the reasons why those women who do enter the engineering field manage to remain in it despite the existing challenges. Understanding these factors or reasons will inform strategies designed to change the organizational structures that lead to women's underrepresentation in engineering. This study attempted to gain an understanding of some of the reasons by asking questions about the participants' experience of being a woman in engineering; how they have dealt with their gendered position in engineering; and what they attribute their continued presence in the field to (see appendix of semi-structured interview guide).

This section has discussed the reasons for the study and its objectives. The next section will provide an overview of the different chapters, explain how the study was conducted and provide the study's findings.

1.5 Overview of Chapters

In addition to the introductory material above, the study consists of the following chapters:

1.5.1 Chapter 2: Literature and Theory

This chapter provides a review of literature on women in engineering. It begins with a discussion of the status of women in engineering and the challenges they face due to their gender. The gendered culture of the engineering discipline is explored as a contributing factor to the underrepresentation of women in the field. Literature on the South African situation specifically is also reviewed in order to provide a local context for the study, which focuses on the experience of women in South Africa. The chapter closes with a discussion of feminist standpoint theory; the paradigm that was used to guide and inform the research on women academics in engineering.

1.5.2 Chapter 3: Method

Chapter 3 provides a detailed discussion and description of the manner in which the study was conducted. The following issues will be discussed: selection of the research questions,

sampling methods, the execution and analysis of the data, and ethical considerations that informed the research process.

1.5.3 Chapter 4: Findings/Results

This chapter provides a detailed description and discussion of the study's findings as identified through the thematic analysis of the data collected during interviews. It presents and explains the main themes that the transcribed interviews reveal as a step towards the next chapter which discusses the findings.

1.5.4 Chapter 5: Discussion and conclusion

In this discussion chapter, a final overview and interpretation of the research findings is provided along with a discussion of the limitations and obstacles encountered in the study. The chapter links the findings directly to the research question posed and attempts to provide answers, extracted from the data, to the main research question, namely: *How do women in engineering account for their continued commitment to and presence in the field of engineering?* The chapter will show that women in engineering employ a number of strategies to deal with the challenges they face in the field. In addition to coping with the challenges, the flexibility of academia and their passion for teaching, among other things, contribute to their commitment to engineering academia.

The Conclusion summarises the study's findings as they relate to understanding the reasons women academics in engineering provide for their continued presence and commitment to the field. The possible use of these research findings to inform education and policy strategies that are geared towards attracting and retaining women in science, engineering and technology fields is highlighted in this section.

1.6 Conclusion

This chapter provided a detailed discussion of the research problem and the reasons and motivations for the study. An overview of the dissertation structure, the different chapters and the contents of these chapters was also provided. The remainder of the dissertation will provide a detailed description and discussion of the issues highlighted above.

Chapter 2: Literature Review

2.1 Introduction

Women are underrepresented in science, engineering and technology. This problem has been highlighted in many debates in South Africa and the rest of the world. The underrepresentation of women in science and engineering has been attributed to a number of aspects including but not limited to social, cultural, behavioural, personal and environmental factors. While women are underrepresented in engineering, there is a need to provide an explanation as to why those who remain in the field continue to do so. This chapter will review the literature on women in science, engineering and technology as it provides insight on the status of women in engineering; the gendered nature of science; the challenges and obstacles women in science and engineering face and the South African research on women in engineering. In attempting to allow women's voices to be heard, the chapter will conclude with a review of feminist standpoint theory.

2.2 Defining Science, Engineering and Technology (SET)

According to Faulkner (2000, p. 760),

> *"Engineering is an interesting site for investigating gender…because it is an important locus for the social (and thus gender) shaping of technologies, and because engineers represent a particularly visible instantiation of the still durable cultural equation between masculinity and technology."*

Essentially, as a discipline, engineering focuses on the development of solutions to some key problems that confront society. In discussing the field of engineering, literature refers to the science, engineering and technology (SET) sector. In order to understand the links and differences between the different areas of the sector, a definition of each is important.

According to Siepmann (1999), science is the reasoned investigation of phenomena with the purpose of discovering universal principles of these phenomena. Engineering is the goal-oriented process of making tools and systems for practical human use in an effort to exploit phenomena that science has come to make known, for human benefit. Technology is the outcome of both science and engineering (Siepmann, 1999).

Godin (2007) observes that many historians have studied definitions of science in the context of the relationship between science, technology and engineering. In a memorial lecture on the contributions of Danckwerts, a leading protagonist of the need for a scientific approach to the discipline of chemical engineering during the 1950s, Sargent highlights a statement made by Danckwerts that provides a distinction between scientists and engineers, namely: "…scientists solve problems they can, but engineers solve problems they have to" (Sargent, 2002, p. 1076). There is, thus, a sense of necessity in the work of engineers and in the field of engineering itself. In contrast, science is seen as the overarching field within which engineering functions, with science revealing the knowledge and engineering creating useful technology from this knowledge (Lynd, n.d). Essentially, the knowledge generated by science needs only to be correct and consistent with prior knowledge, while that of engineering needs to be useful. Therefore, engineering is the application of science for human benefit (Lynd, n.d). The above descriptions guided this study's discussion of the SET sector and science and engineering in particular. Science is the overarching field from which engineering derives the knowledge necessary in the creation of tools for the solution of problems faced by people.

This study focused on women in the School of Engineering at the University of Pretoria. This includes the departments of chemical; civil and bio-systems; electrical, electronic and computer; industrial and systems; materials science and metallurgical; mechanical and aeronautical and mining engineering. These departments constituted the field of engineering in the study, while science referred to the overarching field of observation and investigation, human, physical, biological or otherwise, which also encompasses the field of engineering.

2.3 Status of women in engineering

The SET sector is generally described as male-dominated and is often regarded as a field in which women are less equipped to perform well in. Although recent trends point towards an increase in the number of women enrolling in engineering programs, women continue to remain underrepresented in the higher levels of engineering career paths, both within academia and in non-academic settings (Royal & Mamaril, 2008). In the United States of America, where much research on women in science and engineering has been carried out, only 3% to 15% of full professors in the top engineering and science departments in 2004 were women (Young, 2004). This figure is remarkably low when seen in the context of the fact that the percentage of women attaining doctorates during the twenty years prior to 2004 were reported as being substantially higher than men. There is, thus, a considerable discrepancy between the numbers of women acquiring qualifications that allow them to

continue with academic careers and the number that actually do so (Young, 2004). In the same year (2004), in South African institutions, only 14% of academic research staff in engineering faculties were women. In other words, only 33 of the 230 academic researchers in the country were women (South African Reference Group, 2004).

As engineering is part of a wider scientific field, the trends that emerge in science can be translated to the field of engineering. The National Advisory Council on Innovation (2009) reported that in South Africa in the year 2009, 19% of women were full professors; 30% were associate professors; 41% were senior lecturers; 51% were lecturers and 56% were junior lecturers. There were more women in lower positions in science, with few women occupying roles that can influence policy. In comparison, men were twice as likely to hold senior positions in other scientific disciplines (Sheridan, 1995), a trend that continues to exist today. The need for research output in order for one to be promoted means that junior lecturers need to publish a significant number of papers in order for them to advance. However, female junior lecturers are often carrying heavy teaching loads or are given extra administrative duties so that their research outputs are rather few. This is one explanation for the low numbers of women in senior positions in science (Sheridan, 1995).

A study to quantify the magnitude of the gender gap in science and engineering at the top 50 universities for electrical engineering in the United States of America (Young, 2004) revealed that on the list of professors, associate professors and assistant professors for the year 2002, only 6.5% of electrical engineering members of faculty were female, with a similar figure emerging of 6.7% of female faculty members in mechanical engineering (Young, 2004). The study aimed to reveal that, while institutions were acknowledging that women were indeed underrepresented in engineering, there was little done to effectively address this problem, as women were significantly still underrepresented (Young, 2004).

Sagebiel (2007) defines a male domain as a “space that includes less than 15% women” (p. 154). The statistics provided above show that science and engineering continue to be male-dominated, with few women in positions that allow them to significantly influence policy in engineering (Davis, 2001). Fox (2010) describes significant participation in academia as referring to the presence of women faculty, their influence and involvement in institutional decision-making on issues including in formulating the curriculum, hiring of faculty and the allocation of resources. Essentially, women in engineering are relegated to lower positions where they have little influence over the structure and culture of departmental proceedings. Therefore, while on paper, engineering departments claim to be aware of the limited

numbers of women present, the status quo remains the same, indicating a lack of proactive measures to change the situation. Women remain unevenly distributed in research occupations and significantly underrepresented in senior positions (Organization for Economic Cooperation and Development, 2011).

2.3.1 The gendering of science

The field of science is associated with rational and systematic thinking, which is stereotypically associated with men/male characteristics as opposed to females who are portrayed as emotional and non-rational (Cronin & Roger, 1999; Sheridan, 1995). However, evidence shows that males and females possess similar abilities in systematic thinking (Moore, 2006). Furthermore, the assumption is that because science is objective, there should be no differences between the contributions of male and female scientists (Cronin & Roger, 1999). Similarly, academic structures of science claim to evaluate and reward academics, both men and women, independently of their gender. Such an approach fails to explain why women are underrepresented in science and engineering as men and women are viewed as equal and uniform with merit being the only deciding factor (Cronin & Roger, 1999). Consequently, such assumptions of scientific objectivity have been challenged by many authors.

Davis (2001) argues that, in reality, men are the gatekeepers in science, and they can impede or advance women's careers in science. Furthermore, Fox (2010) argues that status and rewards in science are not allocated independently of gender. Gender involves cultural beliefs and distribution of resources at the wider societal or organisational level, patterns of behaviour and organizational practice (Cech, 2007). Thus, science's dismissal of the gendered nature of evaluation is indicative of a refusal to acknowledge the limitations of science as objective, particularly in the analysis of social and cultural structures.

Despite the increase in women in the workforce, women remain underrepresented in positions of power within numerous institutions (De la Rey, Jankelowitz & Suffla, 2003). In research carried out by Davis (2001) on the impact of supportive science networks on the retention of women in science, stereotypical and sexist expectations, the hegemonic social structures and practices within science were described as being the reason for the exclusion of women from science (Davis, 2001). The sex-gender system which structures inequalities of all social life is considered a factor of women's underrepresentation in science (Cronin & Roger, 1999). Most studies analyse women's underrepresentation in terms of the obstacles they encounter being due to the culture of science as male-dominated, and thus not

accepting of women's views and ideas (Davis, 2001). Stereotypes that reveal certain expectations of what women will be like and, as such, dictate what they can and cannot do have been found to cause enough discomfort to lead women to drop out of the domain of science (Delisle, Guay, Senecal & Lacrose., 2009; Good, Aronson & Harder, 2008). The culture of science and engineering, like any other male-dominated organizations, seems to work on the principle that, for a woman to excel and have some form of authority in the scientific arena, she needs to reject the feminine and adopt masculine practices and ways of thinking.

Women's ability to effectively participate in traditionally male-dominated areas is attributed to their ability to internalize masculine attributes while distancing themselves from their feminine attributes. Femininity, therefore, seems to have no position in science and in engineering in particular. Women are, therefore, forced to participate in a gendered knowledge and power system that offers little opportunities for them to have a voice of their own (De la Rey & Kottler, 1999). If this is the case, then how does one explain the presence of women in engineering? One can question whether or not these women are not affected by this masculine oppression or if they have learnt to ignore and avoid messages of femininity in order to survive in the discipline.

In her discussion of the gendered and dualistic nature of engineering, Faulkner (2000) also highlights the masculine character of science and engineering as other authors have done (Delisle et al., 2009; Good et al., 2008). She points out that there is an immediate distinction implied in engineering between masculine identities as being technology-focussed, in comparison to feminine attributes that are people-focussed (Faulkner, 2000). This dualism then implies that for a woman to choose to work closely with technology, as in engineering, there is some form of rejection of the social and emotional aspects of herself, which Faulkner (2000) argues, may lead to 'gender inauthenticity'. However, instead of agreeing with the argument that a rejection of femininity occurs when women enter engineering, Faulkner (2000) argues that women engineers construct new versions of femininity for themselves. Engineering is in no way gender-neutral as is presumed and women cannot ignore messages that refer to or highlight their femininity in such settings. Instead, women who participate in engineering find ways of reconciling their identities by deciding either to be the same or different from their male counterparts (Faulkner, 2000; Kandiyoti, 1988). In essence, engineering promotes masculinity and negates femininity and in order for a woman to participate in engineering, there is a need for her to re-adjust her feminine stance. This re-

adjustment may be a possible factor that contributes to the continued presence of women in engineering, and this is what the present study explored.

The burden that women in science face is extensive in its reach and emerges in the form of what will be referred to, in this dissertation, as challenges and obstacles. These are discussed below.

2.3.2 Challenges and obstacles experienced by women

Research on 'women in science' identifies what have become universal obstacles faced by women, with some articles implying that these challenges, both internally and externally caused, are the reasons why women pull out of scientific careers and, why they are underrepresented in engineering (Davis, 2001; Moore, 2006; Pawley, 2004).

As already noted, the practices of science are gendered. According to Sandra Harding, a prominent standpoint theory feminist writer, 'science is totally inside culture' (Harding, 1986). This means that the practices of science do not take place independent of wider societal influences. Therefore, if women are marginalised in society, this marginalisation inevitably affects their level of participation, status and rank within the scientific institution (Fox, 2010). According to Barinaga (1994), the wider societal culture of a country or of a community has an impact on the culture of science as it relates to men and women. First, while the discipline of science has been around for a long time, there appears to be a continuous propagation of the patriarchal ideals that were present at the establishment of the institution. Women in science were overtly discriminated against at the very inception of science as a discipline and this status quo remains today.

In a literature review on women in science, Sheridan (1995) discusses the example of a female developmental biologist named Christian Nusslein Voluard, the winner of the 1995 Nobel Prize in medicine for discovering the genes that shape the development of the fruit fly (Sheridan, 1995). According to Sheridan (1995), Voluard explained that the general attitude she had encountered from her male colleagues in the lab, prior to her discovery, was one of lower expectations when it came to women. Women were given the chance to participate only as a way to prove that they were incapable of performing any task (Sheridan, 1995).

It is a given that men and women are socialized differently and that the roles and expectations imposed on the different sexes may serve as an obstacle to women's ability to succeed, particularly if their actions go against the social and scientific norms excepted of

their gender as females (Sheridan, 1995). Social attitudes about the role of men in families as breadwinners and not child minders, policies towards child care, and the negations of the idea of flexible work schedules, all have a significant impact on the experiences of women in science (Barinaga, 1994; Kalabamu, 2006).

Social attitudes are predicated on the idea that women are responsible for the household, family, and childcare (Barinaga, 1994; Kalabamu, 2006). Consequently, children are viewed as a hindrance, particularly if they are present at the beginning of a woman's career when women are expected to be the most productive (Monhardt et al., 1999; Moore, 2006). The time that is expected to be spent on one's career at the start and the demands of one's children are seen as conflicting and hindering one's progress, especially since, more often than not, women tend to prioritise the wellbeing of their children. As a result, the academic community and the engineering community in particular tend to regard being a wife and a mother as a liability to the organisation (Monhardt et al., 1999).

While research reveals that neither marriage nor children have a significant impact on women's productivity in scientific careers, societal notions of 'proper' roles for women persist even after these women have gained entry into the scientific community (Sheridan, 1995). The perpetuation of ideas of patriarchy in science is coupled with the absence of support systems in wider societal culture that may allow women to combine family and work (Barinaga, 1994).

In addition to the problem of the dual role of women in professional and personal arenas, women face the challenge of a lack of sufficient support in society and in science. In a study by Monhardt et al. (1999), the women interviewed reported feeling that the lack of consistent support made them unaware of information that may have assisted them in the advancement of their careers. As a minority group in science and more so in engineering, women are often isolated and forced to operate on their own. Researchers argue that women entering male-dominated fields often find themselves the only women present; the negative experiences of being alone and different will inevitably have a negative impact on one's performance and subsequently on one's advancement (Keifer, Sekaquaptewa and Barczyk, 2006).

Keifer et al. (2006) conducted a study to assess the impact of what they termed '*solo status'* on the performance of women. Solo status is a feeling experienced when one is the only representative of their social category within a homogenous group (Keifer et al., 2006). It

was found that if a performance is conducted in public, as in panel interviews where the panel is often male dominated, women are less equipped to handle the encounter and are, thus, more debilitated than men due to the solo status experience (Keifer et al., 2006). This has been used to explain the underrepresentation of women in engineering. These suspicions were reaffirmed in the study when men agreed that women in science were at a disadvantage because of their gender (Cech, 2007; Monhardt et al., 1999).

In another study, females reported biases against them most visibly in the recruitment and evaluation processes (Monhardt et al., 1999). The interview procedure was said to be designed by men and because women are not socialised to deal with situations in which they have to defend and market themselves to a deciding audience of fellow academicians, women become disadvantaged (Monhardt et al., 1999). Women are reported as having a harder time in advancing in institutional systems where the guidelines for evaluation and rewards are not specific and precise (Sheridan, 1995). As science was predominantly a male domain from its inception, the guidelines for evaluation were designed to evaluate men. Consequently, women are not always aware of the unwritten rules of engagement in evaluation procedures, thus placing them at a disadvantage to men (Sheridan, 1995).

A 1991 study by Fox provided evidence of the engendered nature of evaluation and reward guidelines of science. In this study 147 psychology chairpersons in the United States of America were presented with ten PhD dissertation summaries for evaluation. For each questionnaire, female names were randomly assigned to four summaries with male names assigned to the remaining summaries. When asked to make hypothetical decisions about whom they would recommend for hire, most evaluators recommended men for the Associate Professor position and the posts of Assistant Professor to women with, ironically, the exact same summaries as those allocated male names (Sheridan, 1995). The study by Fox is a clear indication of the role gender plays in the evaluation procedures of science, and the subsequent underrepresentation of women in science.

There is a clear indication from the literature that institutional practices and structures are biased in favour of men. Women's underrepresentation in engineering can therefore be attributed to such biased practices. The question then arises, how do the women who are currently within engineering and other scientific disciplines continue to operate under such institutional structural conditions?

Garforth and Kerr (2009) highlight that little qualitative research has been carried out to assess the impact of women in science initiatives on the retention of women in science. In a qualitative study carried out by Davis (2001), female members of a 'women in science' support group were interviewed on the value they received from the support group. The findings revealed that women realised that a combination of structural and social forces contribute to their marginalisation within the scientific community (Davis, 2001). Structures and practices in science are described as having blocked women's engagement in science instead of providing useful pathways for them to practice efficiently (Davis, 2001). This finding is in accordance with other literature discussed previously (Esler., Shackleton & Chinsamy-Turan, 2006; Monhardt et al., 1999; Sheridan, 1995).

In response to such restrictive practices, women in science have had to find ways of tackling their problems. The establishment of formal or informal networks of support that serve the purpose of providing females with access to science careers and opportunities to acquire knowledge, skills and resources has been seen as useful and often successful in assisting women in science in dealing with challenges they face (Davis, 2001). This is just one way identified as contributing to women's continued presence in science. A focus on women in engineering in particular will determine whether or not this finding holds true for that particular discipline. The challenges highlighted undoubtedly contribute to the limited advancement of women in engineering (Moore, 2006). While the literature provides an explanation for the impact of such institutional practices on women's entry and advancement in science, there is a limited focus on what factors contribute to women's ability to manoeuvre their way within such structures so that they continue to be present in engineering; a male-dominated arena. Inferences can be made from the challenges documented that the women who continue to be present in engineering do so while overcoming these obstacles in one way or another. It is this assumption that informed the research question and the purpose of the research.

The need to understand the experiences of women in engineering as they relate to the reasons for the continued commitment of this group of women in the discipline will shift the focus of literature from highlighting the obstacles, as has been the general trend, to a more positive focus of highlighting the factors that contribute to the retention of women in such disciplines.

In light of the challenges and obstacles discussed, women in science have to work harder to receive the same recognition and rewards as men. In science, those who prioritise work

ahead of other social and personal responsibilities tend to succeed (Davis, 2001). Successful women in science are those who act in ways that are consistent with these norms (Davis, 2001). Women report having to be extremely cautious in their scientific methods in order to avoid any form of criticism (Sheridan, 1995). They are also required in science to exhibit extra ability in order to compensate for the hindrances associated with their gender (Barinaga, 1994). A female scientist needs to produce, on average, 2.5 times more than a male applicant in order to receive the same competence score (Sheridan, 1995). Gender biases are clearly at play in scientific institutions, and in order for any meaningful and positive change to take place, the gendered nature of science needs to be taken into account in understanding women's experiences and in formulating policies that will encourage women to remain in science, engineering and technology.

2.4 South African research and the relevance of gender

South African researchers have also researched the underrepresentation of women in engineering (Du Toit & Roodt, 2009; Jawitz, Case & Tshabalala, 2000). Forje (2008) states that in their struggle to transform their society and achieve equity, African women have to manoeuvre their way through a culture which promotes the dominance of men. According to Du Toit and Roodt (2009), most staff members in engineering departments at tertiary institutions are White and male, with very few female members at higher levels of decision-making. Men occupy the majority of the full professorship positions, while women are relegated to middle-management positions where promotion is unlikely (Perumal, 2003). Perumal describes what is termed *'male-deafness'* where women's contributions in meetings are ignored, but when the same idea is put forward in the same words by a man, it is regarded as innovative and impressive. Women are then forced to accept and internalise their gendered roles and subsequently withdraw from participation (Perumal, 2003). Of interest was how some women colleagues in engineering tend to condemn women who attempt to challenge the patriarchal prescribed roles (Du Toit & Roodt, 2009; Perumal, 2003), which is evidence of the failure of women to uplift other women in engineering, contributing to the underrepresentation of women overall.

In South Africa, as in other countries, the gender gap in science and engineering is related to socialization where women are responsible for the family and their role as mothers is highlighted (Esler et al., 2006). The effects of gender socialization extend to the scientific arena where women are given more teaching loads and committee work than men. The argument is that the role of women is needed in academia for the reasons of ensuring some form of gender inclusion, with women academics being delegated to such work (Esler et al., 2006). In one study, it was revealed that men and women in similar categories of productivity

generally do not hold similar academic rankings in science (Esler et al., 2006). Such trends lead one to conclude that something other than productivity is used to determine promotions in academia, and one can infer that gender has a significant influence on evaluation procedures (Esler et al., 2006).

Most research on women in engineering focuses on understanding the obstacles faced by those in the non-academic settings and on undergraduate and postgraduate student's experiences of studying engineering (Case & Jawitz, 2004; Jawitz et al., 2000; Reed & Case, 2003). In 1945 there were no women in engineering in South Africa. By 1974 women had begun to participate in the field of engineering (Du Toit & Roodt, 2009). Research reveals that, while there has been a degree of success in ensuring more females enrol for engineering undergraduate courses, there has been less success in transforming the gender composition of academic staff in engineering departments (Shackleton, Riordan & Simonis, 2006). It became clear that women were and are capable of excelling in engineering; the problem lies in social and institutional barriers that are not welcoming of women in comparison to their male counterparts (Du Toit & Roodt, 2009; Shackleton et al., 2006). The question then arises, if there are few females who serve as mentors and role models in the engineering sector (Chowdhury, Hoo & Pasik-Duncan, 2007), how can institutions attract and retain women in academia (Francis, 2009)? There is a need to understand not only the challenges women face, but also what keeps them interested and committed to engineering. Such knowledge would provide a foundation for retention initiatives and policies that institutions may implement.

2.4.1 Science, Engineering and Technology

As most research focuses on women in science in general or on the undergraduate and postgraduate student population in engineering, literature on physics and other scientific disciplines provides a general picture of what also likely transpires in engineering, as engineering is part of the broader SET sector, usually referred to in most literature on science. A study by Diale et al. (2009) on women's position in physics in South Africa noted that only about 40% of South African researchers in science, engineering and technology are women, with women in physical science occupying the lower positions. Although their study was focused on physical science as a discipline, many of the issues associated with women in physics can be generalised to all scientific disciplines including engineering (Diale et al., 2009). Issues identified included discrimination, both conscious and unconscious, in the hiring of women and in the awarding of grants (Diale et al., 2009). The South African Council for Scientific and Industrial Research (2006) found that women in engineering

disciplines tend to be younger and receive a significantly smaller slice of the rewards and recognition on offer. Women are also usually clustered in certain scientific domains, such that male domination remains visible in certain male stereotyped disciplines such as physics and engineering (South African Council for Scientific and Industrial Research, 2006).

According to Diale et al. (2009), there is a need to improve the scientific climate within which people operate, in a way that is beneficial to women. When the study was published in 2009, nearly all South African university physics departments had either one or no female academics in permanent positions, a trend identifiable in the engineering discipline/field (Diale et al., 2009). In 2009 the School of Engineering at the University of Pretoria had only 10 females, compared to 94 males (Francis, 2009). A quick view of the University website revealed that a year later the number of women had not changed much, with 15 women being listed (University of Pretoria, 2010).

In addition to providing support for women in balancing their careers and family responsibilities, a hindrance to women's advancement as identified previously, there is also a need to enhance the fairness of selection and promotion processes (South African Council for Scientific and Industrial Research, 2006). Role models have been identified as being an important factor in encouraging women to advance in their careers. There is also need to offer support in the face of negative personal experiences that may dishearten or result in high attrition levels of females in scientific disciplines (South African Council for Scientific and Industrial Research, 2006). The influence of such role models and support systems on women academics in engineering as a positive retention factor will need to be established and further substantiated.

The literature review section has shown that there has been considerable research carried out on the problem of women's underrepresentation, the challenges and obstacles they face, and the gendering nature of engineering structures and practices. It is generally acknowledged that there is a need to attract women to and retain them in the field of engineering. However, there is limited research that focuses specifically on women in academia and what reasons this group of women provide for their continued commitment to the field of engineering. There is a need to focus on the positive factors that women in engineering may be utilising in order to cope with and overcome the challenges they are facing. This study attempted to provide such a focus and hopes to provide insight into new ways of retaining women in engineering.

2.5 Theoretical framework and paradigm

Following the analysis of the literature on women in science, engineering and technology and given the desire for the research to gain an understanding of women's experiences as they relate to their reasons for continued commitment to the field of engineering, a discussion of feminist theory and feminist standpoint theory will provide insight into the theoretical framework which guided the research.

2.5.1 Feminist theory

According to Riley, Pawley, Tucker and Catalano (2009), the use of feminist theories in science, engineering and technology is useful in that they acknowledge gender and power relationships associated with gender. Feminist scholars have argued that in order to understand the causes of women's underrepresentation in engineering, one has to conceptualise gender as a socially constructed notion within a patriarchal context (Riley et al., 2009). Gender is therefore seen as a fundamental way in which relations of power in society manifest and how these, in turn, influence the theories and practices of engineering that are carried out (Riley et al., 2009).

The idea of a gendered discipline of engineering forms the basis of questioning the claims to objectivity made by engineering and allows for researchers to focus on the experiences of women in engineering as, at first, a homogenous group in relation to men (Riley et al., 2009). With this in mind, feminist theory was used in the study. By allowing the voices of women to be heard through research, and the consciousness raised through the research of topics relevant to women, women may be assisted in overcoming social and institutional inequalities (Holloway & Wheeler, 2002). Feminists claim that inequality between the sexes has always existed, however, a systematic and institutionalised inequality between men and women, resulting in the oppression of women emerged over time (Jonasdottir, 1988). Feminist research acknowledges the gendered nature of the individual's reality. Gender is, therefore, a structural category that is inherent in each person's experiences within any institutional and social structures (Denzin & Lincoln, 2005).

Feminist research accepts the fact that women's oppression is shared, and it is through these shared experiences that we come to understand these experiences through the personal accounts of women (Stanley & Wise, 1983). The point of departure for feminist researchers is that women are oppressed and the oppression of women has consequences for all of society (Stanley & Wise, 1983). The nature of reality (ontology) is such that all social knowledge is generated as part of a product of human social experience (Stanley &

Wise, 1983). Sandra Harding argues that women's experience provides a good starting point for new knowledge (Braidotti, 2003; Pillow, 2002). The role of the researcher as an active and co-constructing agent in the research process is recognised, the researcher is, therefore, not superior to the participants, but neither is he or she devoid of an opinion (Stanley & Wise, 1983). The context is important in the acquisition of knowledge and is also taken into account.

2.5.2 Origins of feminist standpoint theory

'Feminist theory' is a broad framework of thought within which 'feminist standpoint theory' can be located. According to Patricia Hill-Collins, a prominent Black feminist standpoint theorist, feminist standpoint theory is an interpretative framework dedicated to highlighting how knowledge is central in creating, maintaining and eventually changing unjust systems of power (Hill-Collins, 1997). Feminist standpoint theory emerged in the late 1970s and early 1980s and it was influenced by Marxist standpoint theory which was originally developed to highlight the wage exploitation and subsequent impoverishment of European working-class populations (Hill-Collins, 1997). It emerged as a critical theory about the state of relations between knowledge production and power structures (Harding, 2004). According to Harding (2004), the conventional view was that the political and emotionally laden ideas were not objective enough to contribute to scientific claims to truth. Feminist standpoint theory challenged this assumption and was identified as a method of feminist research which could be used to highlight the oppression of women through truth identified in women's lived experiences (Hekman, 1997; Hill-Collins, 1997). According to Stoetzler and Yuval-Davis (2002), one of the cornerstones of feminist standpoint theory has been its challenge of positivist ideas of objectivity as leading to real truth. Feminist standpoint theory advocates for the inclusion of and importance of the positioning of the social agent in social structures as being important in knowledge creation (Stoetzler & Yuval-Davis, 2002). Experiences and the ways in which individuals and groups perceive phenomena within their settings are seen as serving a mediating function in the transformation of people's situatedness into knowledge (Stoetzler & Yuval-Davis, 2002).

Hegemonic universal knowledge has tended to ignore the experiences of women (Assiter, 2000). In the struggle for recognition, women have called for the validation of their own perspective. In opposition to modernist ideas that were viewed as perpetuating masculine ideas of knowledge and truth, feminist standpoint theory served as an alternative version of the truth; a truth that did not privilege the masculine, but instead provided a platform for women's version of the truth to be acknowledged (Assiter, 2000; Hekman, 1997). Feminist

theorists agree that feminist standpoint theory emerges from the idea that women's unique standpoint in society allows for a unique version of reality and truth, as experienced by these women (Hekman, 1997; Longino, 1993; Stoetzler & Yuval-Davis, 2002). Feminist standpoint theory emerges as a framework through which the differences of experiences between men and women are explored and serves as a way through which the oppressed can gain a public voice (Harding, 2004; Mc Laughlin, 2003). Women are viewed as an oppressed group in a system which places masculinity as superior to all others, and it is this masculine, hegemonic and androcentric mainstream thinking that feminist standpoint theory aims to destabilise (Faulkner, 2000; Hekman, 1997; Longino, 1993). Ultimately, a destabilisation of masculine hegemony will lead to the generation of knowledge that is capable of producing political change which will result in a less repressive society (Hekman, 1997; Mc Laughlin, 2003).

According to Hekman (1997), feminist standpoint theory raises a central question for feminist theory as a whole: "How do we justify the truth of the feminist claim that women have been and are oppressed?" (p. 342). In the quest for versions of truth, feminist standpoint theorists have been guided by two main assumptions, first, that knowledge is situated and perspectival, and, second, that there are multiple standpoints of knowledge (Hekman, 1997).

Feminist standpoint theory focuses on the situated, local and communal aspects of knowledge (Hekman, 1997). Sandra Harding argues that feminist standpoint approaches proceed from the idea that the oppressed have a privileged viewpoint that allows them to access reality as it truly is, as opposed to the dominant group whose view is seen as being partial (Harding, 1986). Women's experiences are seen as a source of knowledge about oppressive processes (Mc Laughlin, 2003). The feminist standpoint provides an opposing viewpoint of the world that challenges the dominant patriarchal structures of knowledge (Mc Laughlin, 2003).

Feminist standpoint theory advocates for the use of marginalized lives as better places from which to begin to ask questions about existing social structures (Stoetzler & Yuval-Davis, 2002). The argument is that access to marginalized groups is easier in comparison to dominant groups that are seen as being protective of their positions in the unequal status quo and are therefore much difficult to gain access into (Stoetzler & Yuval-Davis, 2002).

Feminist standpoint theory values the collective experience in the creation of knowledge, therefore, the definition of a 'group' is of importance (Stoetzler & Yuval-Davis, 2002). A

group can refer to those who share a common location or a particular positioning or those who share a common identity (Stoetzler & Yuval-Davis, 2002). The notion of standpoint, therefore, refers to the idea of groups having a shared history based on their shared location/standpoint in relations of power (Hill-Collins, 1997). Standpoint theory argues that groups who share common localities in power relations also share similar experiences as they exist within such hierarchical power relations (Hill-Collins, 1997). Therefore, women who participate in particular institutions in which relations of power exist, such as in engineering, are perceived as interpreting their experiences within the particular institution in similar ways. While there seems to be an underlying acceptance of individual differences in experience, the theoretical framework takes the overall experiences of women as a homogenous entity from which one can begin to grasp the idea of an alternative version of reality.

Feminist standpoint theory becomes a starting point for dealing with women's issues on a broader level through bringing women's group consciousness to light, as this consciousness presents itself within particular contexts and at particular times (Hill-Collins, 1997). Multiple standpoints can be interpreted as referring to the different versions of truth between different individuals; different groups of women or even different genders. Feminist standpoint epistemology, however, focuses on an initial exclusion of differences amongst women, in order to present its ideas (Mc Laughlin, 2003). This exclusion does not mean that difference is dismissed; instead it can be taken as an advantageous element in the construction of truths that will collectively lead to the emancipation of women from hegemonic masculine structures.

2.5.3 Criticism of feminist and feminist standpoint theory

Feminist standpoint theory has continued to attract criticism from the moment it emerged (Harding, 2004; Hekman, 1997). Criticism of standpoint theory, like the criticism of feminism as a whole, focuses on the problem of 'differences' in oppression and in experiences of the oppressed group (Harding, 2004; Hekman, 1997). Critics argue, and rightly so, that not all women have the same experiences (Harding, 2004).

Feminist theory and feminist standpoint theory introduce the possibility of an essentialist account of women's experiences such that all women are seen as being one homogenous group, not differentiated by other factors such as race or social class. Hekman (1997) raises similar concerns in her analysis of feminist standpoint theory by asking that "…if…we acknowledge that there are many realities that women inhabit, how does this affect the

status of the truth claims that feminists advance?" (p. 349). In answering this question, Hekman (1997) herself provides what she deems an appropriate manner in which to tackle this problem. Taking from arguments set by Patricia Hill-Collins, Hekman (1997) agrees that the ideas that are validated by the different standpoints serve as the most acceptable versions of the truth. There is no such thing as 'the voice of women' according to these theorists, as such a person does not exist; instead, the collective voices of women provide a starting point for claims to truth, which women may or may not always agree with. Furthermore, it is in the lack of assent of some women to the claims of truth made on their behalf that knowledge continues to be created and new versions of truth are explored and understood (Harding, 2004). Feminist epistemology is about finding ways to draw knowledge from the experiences of the individual. By basing knowledge on experiences, it is possible for scholars to recognise differences and women's agency and incorporate them in the theorizing process (Mc Laughlin, 2003).

There is also criticism against the idea that the point of view of the oppressed offers a more truthful version of reality (Hekman, 1997). In the same way that the standpoint of the oppressed offers a version of the truth, the standpoint of the oppressor does the same (Hekman, 1997). The only difference is that the voices of the oppressors and the dominant groups have been heard and continue to be the basis from which knowledge is produced. Feminism and feminist standpoint theory advocate for a situated and localised knowledge whereby starting from the lives of women leads to socially constructed claims that are less partial and less distorted than similar claims that may emerge if one should start from the lives of men who occupy a dominant position in institutions (Assiter, 2000; Hekman, 1997).

In addressing the question of the differences in experience and the different versions of truth that may emerge and how these may impact on the researcher's ability to effectively carry out research in feminist theory, Hekman (1997) once again provides a solution. Hekman (1997) points to the use of Weber's concept of the '*ideal type'* that claims that no aspect of social reality can be apprehended without presuppositions. In order for one to avoid the problems that arise in trying to account for multiple versions of reality or truths that emerge in a particular setting among a particular group, the researcher is urged to rely on his/her own values that influenced the choice of the phenomenon to be studied in the first place (Hekman, 1997). Similarly, according to McLaughlin (2003), once experience becomes the basis of theorizing and activism, the question then becomes one of determining which core experiences the women participating are supposed to share. Thus the researcher in this study determined that the women in the study would share their identities as women

academia in engineering at the University of Pretoria. Gender is another unifying element and is already recognised in feminist research as being the starting point for research inquiry (Stanley & Wise, 1983). For the purposes of this study, women were viewed as a homogenous group for purposes of reaching a collective description of the reasons women provide for their continued commitment to engineering. However, provision was made to highlight and include in the findings, any differences that may have emerged in the research, at the discretion of the researcher.

Feminist theory has also been criticised for implicitly implying that because women are oppressed, they have a limited degree of agency over their own lives (Braidotti, 2003). However, feminist theory does acknowledge the fact that women's experiences have the potential to generate different forms of knowledge that can challenge male domination and incite societal change. By trying to gain an understanding of what reasons women give for their continued presence in engineering, the research attempted to reveal the amount of agency these women have.

As literature reveals, engineering is masculine in nature, and while men may be most capable of solving problems that relate to masculinity, women are themselves best at coming up with solutions for problems faced by women, and yet women continue to be underrepresented in engineering and other scientific disciplines. Feminist theory, therefore, allows women's experiences to be heard in an effort to provide a platform for women to come up with effective solutions to their own problems, in this case, in addressing the problem of their underrepresentation in engineering.

2.6 Conclusion

In trying to understand the position of women in engineering and in gaining insight into the reasons for women's continued commitment to the field of engineering, the role of gender in engineering needs to be acknowledged. The voices of women need to be heard and the experiences of women in engineering can provide insight into the reasons women remain committed to engineering despite the many obstacles and challenges they may encounter. Although women are underrepresented in engineering, there is a need for research to focus on understanding what reasons women in engineering provide as an explanation for why they remain in the field. There is a need to focus on ways to retain women in engineering, and female academics stories will assist in formulating the necessary retention strategies.

Chapter 3: Method

3.1 Introduction

The last chapter highlighted the challenges women in engineering face and the fact that, while there has been much focus on identifying these challenges, there has been little focus on understanding why these women remain in the field. In order to gain an understanding of the experiences of women academics in engineering and to identify what reasons they provide for their continued presence and commitment to the field of engineering, it was deemed appropriate to use qualitative methodology, as guided by the research question. This chapter will provide a description of the research design used to gather data for the research, purposive sampling, the structure of the interviews, the analysis of the data and the strengths and weaknesses of all these elements. Finally, a discussion of ethical challenges follows, together with a discussion of the reflexivity of the researcher throughout the research process.

3.2 Research design

3.2.1 Qualitative research

Qualitative research is ideal for understanding phenomena as experienced by individuals and groups (Cronin & Roger, 1999; Flick, 2009). This research approach allows the participants' experiences to be revealed in a manner that enables the reader to gain an understanding of the underlying reasons for a phenomenon's occurrence (Gergen, 2001). While quantitative research has allowed researchers to assess the number of women present in science in comparison to men, qualitative approaches allow for an understanding of why and how these disparities occur. Qualitative research methodology involves an interpretive and naturalistic approach to the world and attempts to make sense of phenomena based on the meanings people bring to them (Denzin & Lincoln, 2005; Flick, 2009).

Qualitative research is interpretative and studies the world as it is understood and experienced by its inhabitants, with the aim to develop new knowledge about a phenomenon. It is not based on testable hypothesis, but on participants' own beliefs and experiences (Flick, 2009; Ohman, 2005). Open-ended questions are often used in qualitative methods, as they aim to encourage the participant to "...tell their story" (Ohman, 2005, p. 275). Through reflexivity, the researcher also engages in processes to acquire rich descriptions of people's lived experiences. This is done while acknowledging and

continuously reflecting on one's preconceptions on the topic as the researcher (Burck, 2005; Langdridge, 2007).

As the main aim of the research was to gain a first-hand account of the experiences of women academics in engineering with regards to the reasons they believed or felt had contributed to their commitment to the field, qualitative research design was a more suitable design to use, in comparison to other research designs. The research design enabled the participants to reveal their own lives as women in a male-dominated field and allowed the researcher to gain insight into the experiences of these women, so as to facilitate an understanding of their reasons for remaining present and committed to the field of engineering.

3.2.2 Method

3.2.2.1 Non-probability sampling: Purposive sampling

Upon developing a research design, as informed by the research question, an appropriate sampling method was selected and used to identify a suitable sample for the research. Qualitative research makes use of non-probability samples in which the units of study are deliberately selected to reflect particular features of groups within the sample population (Ritchie & Lewis, 2003). Non-probability sampling is conducted when the researcher may not know how many people make up the population. In this study, the sample was put together from the list provided on the University of Pretoria, School of Engineering website which may not be a comprehensive list, and therefore makes it difficult for one to ascertain precisely how many women academics in total, are present in the School of Engineering. However, qualitative research samples are not structured to be statistically representative and the research carried out had no intention of exploring the experiences of women in engineering as a universal occurrence. Instead, the findings of the study as laid out in the chapter to follow are to be viewed as relevant to the academic women present in the School of Engineering at the University of Pretoria in the year 2011 when the research was carried out. The characteristics of the population were used as the basis of selection of participants and therefore the sample was suitable for a small and in-depth study (Ritchie & Lewis, 2003).

In carrying out this research, purposive sampling was used where the participants were selected because they had particular features or characteristics which enabled a detailed understanding of women's everyday experiences of existing within engineering (Ritchie & Lewis, 2003). Purposive sampling is the deliberate selection of a participant based on qualities the participant possesses (Tongco, 2007). The deliberate selection of participants

ensures that the key aspects of relevance to the subject matter are present and that, within each of the designated criteria, an element of diversity is included so the research can reveal the impact of the characteristics concerned (Ritchie & Lewis, 2003). The researcher decides what needs to be known and finds people who can and are willing to provide the required information (Tongco, 2007)

3.2.2.2 Advantages and disadvantages of Purposive Sampling

Purposive sampling is used in qualitative studies. While the sampling technique is appropriate in this study, there needs to be an awareness and acknowledgement of the advantages and disadvantages of using this sampling technique.

When using purposive sampling, one should remember that the results acquired are limited to the population under study and it is important for the researcher to be aware of this bias throughout the study (Tongco, 2007). According to Dane (1990), purposive sampling allows for the researcher to focus on the people who have the desired knowledge and information on the issue being explored (Devers & Frankel, 2000). By selecting particular academic women in the School of Engineering for the study, relevant information was acquired and this was done in an economical and time-efficient manner. The researcher purposely selected women academics in engineering who represented different levels of professional advancement to gain a holistic picture of the experiences of women academics in engineering at all levels of their professional career, from junior lecturers to senior level lecturers and heads of departments. Purposive sampling allows for the diversity of the targeted population to be included in the research such that the findings are more indicative of the different levels of experiences that women endure in their different positions within engineering academia.

While purposive sampling is advantageous in some ways, it allows for selection bias to occur (Tongco, 2007). Selection bias may occur when the researcher has direct influence over who participates in the study so that the sample is made up of a certain participant characteristic and can influence the findings that arise from the study (Shadish, Cook & Campbell, 2002). Purposive sampling aims to find the participants that can best answer the research question, and while there is bias in the selection process of participants, this is what it aims to do and because qualitative research is explorative in nature, the participants selected may reveal new insights to the researcher, which may be useful for further research endeavours.

In selecting the participants for the study, the researcher identified a range of typical cases, deviant cases and negative cases to make up the sample (Devers & Frankel, 2000). Women academics in engineering were identified from the sampling frame and included senior academics, and based on information form the literature, the deviant case was that of that of a head of department. The normal cases were made up of the lower level academics and teaching staff. Negative cases (exceptions to the rule cases) were the female academics in male-dominated departments within engineering, for example, electrical, electronic and computer engineering and chemical engineering (Note: This is according to the sampling frame used and may not be the full reflection of the departmental constitutions). The departments of materials, science and metallurgical and civil engineering both had a deviant and a negative case. The two women in these two departments were identified as deviant cases due to their positions as a heads of departments. The participant in civil engineering was also identified as a negative case as she was the only woman recognizable within the sampling frame from that particular department.

The use of purposive sampling means that the researcher alone becomes the judge of which participants are included in the study and what information becomes viewed as reliable (Tongco, 2007). Despite the inherent bias in purposive sampling, this method of sampling is useful when time and resources are a constraint, as participants can be identified quickly (Tongco, 2007). Throughout the research, the researcher remained aware of the possible bias present both from the researcher and from the participant (Tongco, 2007).

3.2.2.3 Sample

According to Groenewald (2004), in qualitative research, the phenomenon determines the type of participants required. For the purposes of this study and taking into account the sampling requirements identified previously, an initial sample pool of 17 female academic members of staff in the faculty of engineering was identified. The researcher hoped that at least eight (8) of the 17 women would be willing to participate in the study. A sample of eight participants is sufficient and consistent with homogenous sampling used in qualitative research studies (McKiernan & McCarthy, 2010). Academic staff members were defined as those who were employed as junior and senior lecturers or Professors (Associate and full) employed by the University in either a contract of full-time position at the time the study was carried out. The broad definition allowed for a larger population base from which a suitable sample could be drawn as the numbers of women present in engineering is recognized in the literature as being low (Davis, 2001; Garforth & Kerr, 2009).

The study was conducted with female academic staff in the School of Engineering at the University of Pretoria, Hatfield campus as participants. A list of the 17 possible participants (sample frame) was retrieved from the website of the School of Engineering accessible through the University of Pretoria website. After a list of the women in all the departments in the School of Engineering was compiled, as were visible on the website, each of the possible participants was approached via electronic mailing (e-mail) with a brief explanation of the study being provided. Potential participants were requested to make themselves available for a meeting should they be willing to participate in the study.

A single contact session, as was scheduled via electronic mail, occurred in which the purpose of the study was explained to the participants, and they were told that their participation would be an invaluable contribution to the study as the information gained may be useful to other women in academia in engineering. In the same meeting verbal consent for participation was requested and obtained prior to commencement of the interview. English was the language used in conducting the research, as English is a recognised medium of communication and teaching at most tertiary institutions.

The final composition of the participants in the study consisted of nine (9) women academics in engineering, all White. The participant group consisted of women in senior, middle and junior level posts within the different engineering departments.

3.3 Data collection strategies and procedure

3.3.1 Semi-structured interviews

The collection of information was carried out using one-on-one semi-structured qualitative interviews, which allow for an individual revelation of experiences (Davis, 2001). Interviews can provide access to the meanings people attribute to experiences they encounter in their social worlds (Ritchie & Lewis, 2003).

The structure of semi-structured interviews is such that they are flexible, leaving room for other topics to be discussed as they emerge during the discussion (Hove & Anda, 2005). Interviews bring out deeper personal experiences of individuals and allow one to rigorously differentiate between individual experiences and group experiences as will be voiced by other participants (Langdridge, 2007).

The use of semi-structured interviews is not without its disadvantages. Semi-structured interviews are time-consuming throughout the research process, from carrying them out, to

analysing the data collected (Hove & Anda, 2005). In addition to the time required to carry the interviews out, the researcher is encouraged to remain vigilant of the manifestation of power dynamics in the interview. The researcher determines what the topic of discussion will be and to some extent, the main areas of discussion as directed by the semi-structured interview guide. However, an advantage is that the questions serve as a guide for the conversation, while allowing the participant to discuss other aspects they wish to talk about as they relate to their experiences and attributions (Hove & Anda, 2005).

Qualitative interviews are designed in such a way as to allow a revelation of the lived experiences of the people involved with the issues being researched (Groenewald, 2004). Questions asked are directed towards the participant's experiences, feelings, beliefs and convictions about a particular issue (Groenewald, 2004). The use of semi-structured in-depth interviews allowed individual experiences of the women academic staff members in engineering to be revealed and understood and this contributed to answering the question as to what they attribute their reasons for remaining in the field of engineering are, as revealed in their accounts of their experiences.

3.3.2 Data capturing and analysis

All interviews were audio recorded and transcribed verbatim for analysis (Monhardt et al., 1999).The emphasis on in-depth understanding and the importance of the interviewee's language usage as a way of making sense of his or her world meant that tape-recordings, which accurately capture the interview discussion were essential as note-taking could have led to the distortion of the discussion (Ritchie & Lewis, 2003). However, notes taken by the researcher ('memoing') were still used in order to gather extra information such as the occurrence of different activities within the interview setting, and other non-verbal nuances that could not be captured by the tape recording.

The recorded data was transcribed by the researcher and participants' demographic information, such as gender, race, nationality and ethnicity, were also noted to assist in the analysis of the data (Webb, 2002). Before the interview began, participants were informed that their discussions would be recorded and consent was sought. Permission for these recordings was elicited and the researcher was well prepared to take notes in the event that a participant refused to be recorded. However, no such incidence occurred.

3.3.3 Data Analysis

Qualitative research asserts that multiple realities exist and are equally valid. In the same manner, reality can be interpreted in various ways and the understanding gained is subject to individual and subjective interpretations of the reader (Graneheim & Lundman, 2004). Thematic analysis, using Atlas.ti 5 software, was used in the analysis of the transcriptions acquired (Bos & Tarnai, 1999). Thematic analysis is a means of analyzing texts and it is also concerned with the context of the participant's social reality. It is an explanatory tool used to find the meaning of textual material (McKiernan & McCarthy, 2010). Thematic analysis procedures serve the purpose of conveying the meaning of texts as they are unfolded via a process of interpretative reading (Bos & Tarnai, 1999). Both the social environment in which the text arose and the position and environment of the interpreter of the text are included in the process of evaluation (Bos & Tarnai, 1999).

In carrying out analysis of a text, thematic analysis creates categories. A category is a "...group of content that shares a commonality...a descriptive level of content and can thus be seen as an expression of the manifest content of the text" (Graneheim & Lundman, 2004, p. 107). Manifest content can be described as the explicit content that a text reveals and that describes the visible aspects of the text (Graneheim & Lundman, 2004). From the categories identified, underlying meanings called 'themes' are then identified and these are then used to understand the latent context of the text (Graneheim & Lundman, 2004). A theme is an area that is expressed by multiple participants within the discussions (Wilbur, 2002).

Thematic analysis procedures are criticised for being useful only for descriptive purposes. However, their ability to classify these descriptions is useful in gaining an understanding of the texts analysed (Bos & Tarnai, 1999). Feedback is necessary in the process of data analysis and interpretation (Aronson, 1994). Therefore, the researcher made use of the themes highlighted in the interview discussions to obtain feedback from the participants during the preliminary phase of interpretation where member checking by participants occurred (McKiernan & McCarthy, 2010).

3.4 Validity and reliability

Scientific rigour in any form of research is expected (Ohman, 2005). Qualitative research uses different concepts to assess the rigour of the study, in comparison to the concepts of reliability, validity, 'generalisability' and objectivity used in quantitative research (Ohman, 2005). The researcher acknowledged the problems that could arise in this regard and made every attempt to limit these problems. The following section will highlight issues pertaining to

the different aspects of validity and reliability, including how potential problems were addressed.

Internal validity in quantitative research is referred to as truth value or credibility in qualitative research. This analyses the ability of the research to capture multiple realities (Ohman, 2005). The current study aimed to understand the multiple realities of the individuals and the group as these realities are experienced in their position as women in engineering. The credibility of the research refers to the ability of the data and the process of analysis to address the intended focus of the research (Graneheim & Lundman, 2004). Graneheim and Lundman (2004) put forward two ways in which to ensure that a research study is credible. Firstly, the researcher should select participants with various experiences as this provides a variety of responses to the research question (Graneheim & Lundman, 2004). A second suggestion is that in the analysis of the data, there should be agreement among the researcher and the participants so as to determine whether or not various researchers would agree with the manner in which the data is sorted and analysed (Graneheim & Lundman, 2004).

The participants selected for the study through a convenient purposive sampling method were those who the researcher believed would provide relevant information for the study. Furthermore, the selection of participants was such that the final participant group provided insight into the differences and similarities in experiences as was identified in the accounts of the experiences of women academics in engineering and what reasons they provide for remaining in the field of engineering. The transcriptions were made available to the participants for verification and the dominant themes and interpretations made in the first draft of the research report were also made available to them for similar purposes. The process of inviting confirmation and review of findings from the participants is referred to in qualitative research as ‘member checking’. This process not only ensures that the participants are involved in the study, but also serves as a form of triangulation. In qualitative research the use of multiple methods of data analysis is called ‘triangulation’, and this ensures that the data captured and the results obtained from the data are exhaustive revelations and that if the data from all the methods are similar, the results can be viewed as trustworthy (Graneheim & Lundman, 2004; Ohman, 2005).

Generalisability or external validity in quantitative research concerns the question of transferability in qualitative research (Ohman, 2005). Transferability is the extent to which the findings can be transferred to other settings and groups (Graneheim & Lundman, 2004).

Qualitative research works under the notion that the transferability of the research findings is something that can only be determined by the reader. While the researcher can make suggestions, the reader alone can ascertain whether the findings are applicable to the different situations they encounter. In addition, qualitative studies do not aim to produce findings that are applicable to other situations other than the one that is under scrutiny (Hopkins, 2007). The sample choice also limits the transferability of the findings as the participants in the study were selected based on their ability to provide information on the focus of the research, that being, the experiences of women in the field of engineering.

In place of the measure of reliability in quantitative research, qualitative research uses the term 'dependability', instead (Ohman, 2005). To assist in the possibility of replication, the research process is described in detail and documented for use by other researchers (Ohman, 2005). The methodology and data capturing process of the study have been provided in detail, as has been described and discussed throughout this chapter. The records serve as an audit trail that allows for replication of the study by other researcher's should they wish to do so.

Finally, neutrality or objectivity is analysed on the basis of 'confirmability', which is the researcher's ability to recognize their subjective opinion on the research problem in an effort to achieve a degree of neutrality to the research (Ohman, 2005). Qualitative research emphasises reflexivity (Langdridge, 2007), and this study makes use of the importance of reflexivity of the researcher throughout the research process. In order to make this process transparent, I have provided detailed notes on my own contribution to the research process, particularly regarding the topics chosen and the comments made in the discussion, and how these may have influenced the study (Langdridge, 2007).

3.4.1 Researcher reflexivity

In carrying out feminist research, the researcher is urged to remain vigilant of his/her role in the entire research process. According to D'Cruz, Gillingham and Melendez (2007), reflexivity is "...an individual's self-critical approach that questions how knowledge is generated and, further, how relations of power operate in the process" (p. 75). In addition to this definition, reflexivity can also be described as "...the researcher's own participation in the conception of the research, the choice of methodologies, analysis and documentation [of data]...[it is] a process of constructing knowledge in relations of power" (D'Cruz et al., 2007, p. 78).

In choosing the topic for research, I was motivated first by my growing interest in issues of and about women, particularly in relation to the social hierarchical structures that place women, in most cases, in a subordinate role to men. In trying to gain a deeper understanding of the occurrence of such phenomena, I came to question the areas of society that appear to condone such structures of power, with the field of engineering being one such area. My initial idea had been to determine what obstacles women face in engineering that are a reflection of wider societal hierarchical structures and cultures and that lead to women being underrepresented in this field. However, as I read more on the topic, I realised that there is a need to focus on positive and pro-active solutions to the problems of women's underrepresentation in engineering, by focusing on understanding what keeps those who are present in the field committed. It is such thinking that guided the topic and the research process that followed.

In carrying out the interviews, I was aware of my own influence in the information the participants provided, in their willingness to be open and honest with me and in their hesitation at times. My position as a young, Black female, who is a student at the institution, conversing with who I consider to be superior representatives of the institution within which I am a student was an ever lurking idea in the back of my mind. I therefore approached the interviews with caution, but with a desire to obtain honest versions of these women's experiences as much as I possibly could. The participants appeared to be more comfortable when the tape recorder was off, as opposed to when it was on, and they became more comfortable as the interview progressed. The women seemed very eager to participate and appreciated the chance to "express themselves" (Participant 4) which may indicate a difference between those who responded and those who did not. Their eagerness to participate in the study could also indicate some underlying frustrations or a need to talk about their experiences that they usually may not have an opportunity to do.

In the analysis of the data obtained, while I tried to remain true to the data, I remained aware of my own thoughts and feelings in my attempt to provide a platform for the participants' experiences to be known, and understood in the context of my initial research question. In approaching the women who participated in the study, I had to remain aware of my own position, but also of the position of these women and how my research may impact on them, be it negatively or positively. A few ethical guidelines helped me to remain conscious of the research relationship I had established with these women.

3.5 Ethics

Following the ethical guidelines as provided by the American Psychological Association (APA) I tried to ensure that the study adhered to required and recommended ethical standards.

Participation was voluntary with no incentives offered, or coercion used (Langdridge, 2007; McClure, 2007). The researcher ensured that participants were well informed about the purpose of the study and consent forms were administered prior to commencement of the study. Participants were informed that they were allowed to withdraw from the study at any point should they decide to do so, with no repercussions (Hopkins, 2007; Langdridge, 2007; McClure, 2007).

Confidentiality of the participants was ensured (Ohman, 2005) by allocating identification numbers to the participants. Literature reveals that women's position in engineering is already one of struggle, with those voicing their opinions on the challenges they face as women facing further condemnation (Gupta & Sharma, 2003). Therefore, no real names were mentioned in compiling the report of the findings, in order to protect the identities of the participants, however demographic information was elicited, as the researcher believed it to be useful in understanding the research findings (Langdridge, 2007; Webb, 2002).

Regarding the ethical implications of naming the organization where the research was conducted. The researchers acknowledges the while there may be implications for naming the University of Pretoria, every attempt was made to disconnect individual participants from the organization (Guenther, 2009). However, in an attempt to remain committed to feminist research and its aim to inspire social change, the naming of the organization was viewed as beneficial to ensuring that awareness is raised about the experiences of women in engineering within the institution of choice. Furthermore, as the research was focused on identifying some positive aspects related to being in academia, the reputation of the University was not significantly compromised in a negative manner. The names of organizations other than the University of Pretoria were obscured from the findings as the researcher felt that the identities of the participants could easily be compromised based on their affiliation to these organizations.

Furthermore, information recorded and transcribed is safely stored, with the participants' 'true identities' being kept separate from the identification numbers and information acquired (McClure, 2007). Participants were also consulted about the storage of data and the use of

the research findings when the written consent was obtained from them, prior to commencement of the interview (Gravetter & Forzano, 2009; Shaw, 2003).

Before the study begun, as the researcher, I was unaware of any possible harm to the participants. However, due to the nature of the study and the exploration of an individual's feelings and experiences, the participants were notified of the services offered by the University's Employee Assistance Programme (EAP@UP) (University of Pretoria, 2011) department, located at the University of Pretoria, where they would be able to speak to registered Psychologists should they wish to do so. The researcher also acknowledged that due to the nature of the occupations of the participants, as academics, the time taken to conduct the interview may have been an inconvenience to some, and so only one contact session took place to limit this inconvenience. However, the information gained from the study will be useful to the participants themselves and so it will ultimately be a worthy use of their time to participate in the study.

3.6 Conclusion

This chapter described and discussed the methodology used in conducting this study. Due to the nature of the question, a qualitative research method was viewed as most useful, and purposive sampling was the most appropriate technique with which to identify and select participants for the study. The use of interviews to obtain information is time-consuming, but in order to gain insight into the experiences of women in engineering, interviews are a useful tool. A discussion of the researcher's role and reflexivity, together with ethical considerations conclude the chapter. It is essential to understand the manner in which information was retrieved. A discussion of the methodology allows one to retrace the researcher's steps in a study, but also enables one to understand the findings of a study better. The next chapter will look at the findings of the study as they were identified in the data.

Chapter 4: Results

4.1 Introduction

The chapter provides a description of the participants. In addition, the four main themes, namely, the reasons for entering academia; reasons for staying in academia; gender and engineering: gender in the workplace and dealing with challenges, and sub-themes are discussed and direct quotations as evidence of these themes will be provided. All themes will be discussed as they relate to answering the research question of how women in engineering account for their continued commitment to and presence in the field of engineering, as highlighted in Chapter 1.

4.2 Description of participants

Nine participants were involved in the study, and all of them were White, South Africans selected as described in Chapter 3. The participants' ages ranged between 22 and 45 years old, with an average age of 34 years. To facilitate interpretation, the participants are categorised according to age and status/rank in academia. Those with ages between 20-30 years will be referred to as 'younger' and those 30-40+ years, as 'older'. In terms of status/rank, the participants have been categorised into junior participants and senior participants. Junior participants are those who hold junior lecturer positions in the different departments and are usually also younger in age. Senior participants hold lecturer, senior lecturer and head of department posts, respectively, in the different engineering departments and are usually older in age. Across both age groups, the participants had an average participation in academia of 4 years, ranging from between 1 and 14 years in academia. All participants had some form of experience in industry. Participation in industry was in accordance with the undergraduate engineering degree requirements which include a period of what the participants refer to as 'vac work'. Vac work is essentially when an undergraduate degree candidate spends a period of time working in industry. Some participants had more experience in industry than others, and this also had an impact on their experiences in engineering and in academia.

The participants consisted of married, single and divorced individuals, including mothers and women who have no children. Although all participants were in the School of Engineering, the sample included junior lecturers, lecturers, senior lecturers and heads of departments, of different departments in the school, namely, materials, science and metallurgical engineering, chemical engineering, industrial engineering and mechanical and aeronautical

engineering, respectively. The junior lecturers and some senior lecturers were pursuing their honours, masters or PhD degrees in their particular field of study.

All interviews, except three, were conducted in the participants' offices. Two of the participants were interviewed in the Conference Room located in the department and one participant was interviewed in a coffee shop located on campus. All venues were selected by the participants as appropriate for the interview. The location of the interviews allowed the participants to be in a familiar environment, which the researcher assumed would ensure the participants were relaxed and felt in control of the interview process. The researcher experienced the participants as interested in the study and appreciative of the opportunity to tell their stories. They were all welcoming, and projected a deep sense of pride in their profession as engineers and as engineers in academia.

4.3 Emerging themes

The themes that emerged from the analysis will be discussed below. Quotations from the participants will be provided to illustrate the themes. The participants were named based on the order in which the interviews were conducted, which was itself based on the order in which the participants responded to the request for them to participate in the study. The real names of the participants are not used in the study, to ensure their identity is protected. They will be referred to as Participant 1, 2, 3, 4, 5, 6, 7, 8 and 9, respectively. The following themes and sub-themes were identified from the transcriptions:

4.4 Theme 1: Reasons for entering academia

This theme refers to the reasons, personal or circumstantial, that led to the choice of academia as a career path. The participants revealed the path that led to their position in academia.

During the interviews, the participants were asked to describe how they ended up in their position in academia and why they decided to enter into academia. As the participants responded, a general pattern emerged indicating that circumstances and personal choices influenced their entry into academia. Six of the nine participants mentioned circumstances as a reason for entering academia. The reasons for one's career choice can be used to interpret the level of commitment of that individual, to their career and this may be useful in explaining why these women remain committed to engineering academia.

4.4.1 Opportunity to further education

The participants expressed a variety of reasons for their entry into academia. The younger participants ended up in the academic environment because of their decision to continue studying, either to obtain an honours or master degree. The position of junior lecturer and the benefits that academia offered in terms of study fee cuts for those lecturing at the University, was an opportunity they viewed as being beneficial to them in their pursuit of further education. Academia was not a first choice for the younger participants, but a beneficial opportunity that presented itself to them. The younger participants were clear that they would like to work in industry in the near future, with academia being a place they would like to return to one day. Some of the older participants also viewed academia as an opportunity that presented itself to them when they had left industry. University and departmental management had asked the older participants to join academia as lecturers during their time in industry. For the older participants, when they had left industry, academia was one place they could turn to for employment, often as a short-term solution to their abrupt unemployment. Most of the older participants spoke of how they had not planned to stay in academia for more than their initial contract stipulated, which was usually a two-year contract.

While the younger participants referred to a well-thought-out decision to take up a position in academia in order to assist them to pursue their studies, the older participants, who entered academia for mostly circumstantial reasons, also used the move to academia as an opportunity to continue with their studies. For example, Participant 1 left her industry job and entered academia because her husband (also an engineer) was head-hunted for a job in Pretoria and she decided to move with him. As a previous student at the University, she decided to continue with her studies, and upon enquiring about learning opportunities with the department, she was offered a job as a lecturer and accepted it. She stated:

> “My husband was head hunted...I thought, oh, it’s a good opportunity to study further. The head of the department knew me and he remembered me and he asked me whether I would consider applying for the job and I said, agh, let’s try this for a few years” (Participant 1).

In addition to the circumstances surrounding her decision to support her husbands’ engineering career, her decision was also influenced by the head of department’s suggestion that she apply for a job. Academia as a career choice, thus, seems to have been

influenced significantly by the head of department or the University management for seven out of nine, of the participants.

The participants had some form of affiliation to the institution prior to taking on academic positions. All participants had acquired their undergraduate degrees from the University and were familiar with either the administration staff, the academics, or the head of department, who served as contacts in their journey back to academia.

4.4.2 Negative experience in industry

As mentioned previously, all the participants worked in industry for a period of time. The senior participants who returned to academia from industry revealed that they had experienced industry in a less than positive way. Industry was described as being less flexible, especially for women with children. As Participant 5 explained:

> "I decided to leave [industry name] because of the fact that I have a daughter and they weren't willing to be flexible with me...I asked for flexible working hours for two hours from home, um, seven, uh, six hours on at the office. They refused that as well and, it forced me to resign...I needed more flexibility which the academic world does offer".

Female engineers who have children or other family responsibilities are, essentially, forced to choose between their family and their career, and more often than not, women prioritise their family over their career. The senior participants spoke of how family takes priority for them and this has had negative effects on their ability to finish their research and obtain their post-graduate degrees within the expected time frame. The younger participants spoke of how they anticipated their desire to have children as a possible challenge in the future and saw academia as being the field where they would like to be working, when that moment arises, as they see the academic environment as being more flexible for mothers, in comparison to industry.

The other challenges experienced in industry were not mentioned as direct causes of the individuals' decision to enter academia, but may have contributed to the decision. All participants mentioned that their gender contributed to challenges they faced in industry. For example, Participant 5 said: "In industry it's been difficult. It was...very difficult to break the mould of...that I'm a woman...there it wasn't all sunshine and roses. I struggled a lot there".

The challenges faced by those who were working in industry may have made the decision to leave industry for academia, easier.

4.4.3 Passion for teaching

The passion for teaching also came up as a reason for entering academia. Two of the nine participants indicated a passion for teaching and research, prior to their entry into academia. The rest of the participants realised that they enjoyed teaching only after having entered academia. One of the senior participants chose academia as a career choice earlier on when she realised that, while she disliked research, she had a passion for teaching. Participant 6 said: “My interest has always been fairly overtly in teaching once I realised that I...that’s what I wanted to do...I decided I would finish the PhD so that I could get a teaching job”. Similarly, a younger participant mentioned that she would like to remain in academia, but her reason was her passion for research, which she felt academia allowed her to carry out. Such conscious decisions and reasons for entering academia are not circumstantial, unlike the reasons previously discussed.

A passion for teaching and for research indicates that academia was a choice for the individual, not just one of many career options, and as a result, the likelihood of them remaining in academia is high. In comparison, the participants who entered academia for the opportunity it presented to continue their education viewed academia as a temporary stepping-stone to something else. For example, one senior participant spoke of how she did not plan to stay in academia forever, and the younger participants talked of how they would most likely go to industry and then possibly return to academia later in their career. Thus, their continued presence in academia is questionable. It appears then that a passion for teaching and for research is a factor in keeping women in engineering academia.

4.5 Theme 2: Gender and Engineering: Experiences in the workplace

This theme refers to the experiences of women academics in engineering with regards to their gender and how it plays itself out in the workplace. The experiences have been separated into the industry work setting and the academic work setting, as articulated by the participants.

4.5.1 Industry work setting as gendered

The participants described the industry environment as being male-dominated and said that they struggled in that setting especially if they had a child. Their interpretation of academic life was always in comparison to industry, such that they perceived the academic

environment as better than industry in terms of gender bias. The participants repeatedly mentioned that while they experienced some level of gender discrimination in industry, they were adamant this form of discrimination was absent in academia. Gender was experienced as being a factor in industry. Women felt that industry was rigid and refused to make allowances for women with children. The working conditions and job requirements for an engineer in industry are structured around males, and they do not take females and their other family commitments into account (Stewart, Malley & La Vaque-Manty, 2007). The participants felt that men were, as a rule, not expected to have family responsibilities outside of work

A senior participant said about industry: “In most institutions..., it doesn’t cater for, you know, like giving you a half day job or allowing the men to take more of the responsibility....so the men are just expected to be there and they have no responsibility for family stuff it falls on the women” (Participant 1). Women were expected to be as present and as productive as men, even with the other family responsibilities the women had to take care of. Industry essentially is not accommodating of women’s roles, and this will be elaborated on in Chapter 5.

In addition to the rigid nature of industry structures and culture, the men working in industry were also described as posing a challenge to women. In discussing the challenges women face in industry, a senior participant said: “They [women in industry] often work with men who have very fixed ideas about the role of women...especially older men, um, they feel very threatened by women in the workplace” (Participant 2). The traditional or conventional aspects of industry males were mentioned by a number of participants as a hindrance in that the women were not taken seriously. One’s gender seems to be important at all times, in an industry setting. The women described how they were reminded of their womanhood at all times within this setting. Most of the participants mentioned how their voices were not listened to in industry because they were women. A senior participant said: “I struggled a lot to get heard...I would often say something and then a man would repeat it and they would listen to the man but not to me. He would repeat exactly what I said” (Participant 4). However, other participants mentioned that while one experienced such negativity as a woman, this was done by ‘lower level’ workers and not from other male engineers.

Male engineers in industry are described as being accepting of competent women and the women being seen as engineers first and, as women second. In the words of Participant 9:

> "There is no, uh, sexual discrimination in...the engineering profession...normally the people who choose engineering in my time...especially the men, are not threatened by women, they don't feel threatened by clever women. In fact, I wonder if some of them even see you as a woman".

Similarly, Participant 6 stated:

> "I think that other people have a much more gendered view of what it means to be a woman engineer, than engineers do...Engineers are people who solve problems if you can solve the problem as good then you are as good".

The acceptance of women as equals in industry seemed to occur after a period of time in which women's abilities were monitored, culminating in men's acceptance of these women. As the women proved their competency as engineers to their male peers, their gendered position as women seemed to become less of an issue. There appears to be a process of social transition of the individual from the social group of 'women', to the seemingly exclusive social group of 'engineers', with males being the determinant of one's entry or marginalization within the profession. Participant 4 describes how this transition occurs: "Women in engineering work extremely often cause we have to prove ourselves...it got easier and the last job I had I was a more experienced. I was one of the engineers...I didn't feel that my sex was an issue at all". The women appear to have become accepting of the existing institutional structures of the engineering profession, and view one's need to prove themselves, as being an acceptable requirement for the profession; a rite of passage for a woman, in her transition to becoming accepted as an engineer.

4.5.2 Racial discrimination

Racial discrimination was also mentioned as occurring in industry and this was experienced as a duplicated challenge by the White women. Four of the six senior participants mentioned that they experienced race in industry as a challenge. Examples of ideas that emerged in this regard include what Participants 5 and 6 said:

Participant 5: "There is...in my personal opinion um, race discrimination within [industry name], so you know, although I was a female I still struggled to move up the ranks as quickly as some other people"

Participant 6: "I experienced some of the kind of thing that...I related to be the same kind of

thing as um, young Black engineers who were starting...I didn't get pushed very hard so allowances were made for me, which perhaps didn't necessarily help me to develop, whereas if I had been a young White guy, I would have been shat on a lot more...and pulled into line"

Participants 2 and 4 alluded to the fact that while Black, female, undergraduate students were not always given credit for their efforts at university level, they were at a significant advantage in industry in post-apartheid South Africa, as a result of the Black empowerment policies in place in the country.

4.5.3 Academia work setting

The experiences of women academics in an academic environment are important in understanding their reasons for remaining in engineering academia. This sub-theme highlights the gendered experiences of academia by the participants.

4.5.3.1 Academia vs. Industry

The experiences of women in academia were highlighted in comparison to industry. Academia seems to provide the flexibility that these women require and so can be seen as being more accommodating of women's other roles, as mothers and as wives. However, this flexibility seems to be inherent in academic culture and is not exclusive to women. Men in academia also benefit from this flexibility. The participants expressed their satisfaction with academia, pointing out how gender is not an issue in that setting. However, in contradiction to this expression, the participants did acknowledge that sometimes in academia their gender becomes apparent. Participant 7, a junior lecturer said, "In the beginning I did feel that some of the, especially the older males, treated us differently from them because we are um, three lady junior lecturers and one male...Professors would...go to the guy and ask him for assistance, but it changed in the past few months when we proved ourselves to them". The need to prove one's competence was repeated by all the junior participants.

Most of the participants also mentioned that they experienced within academia, expectations to conform to traditional gender roles. A senior participant said: "Do I think that the women get left making the tea sometimes? Yes I do...That happened in industry it does happen here...conventionally the women do get more the hostess role there is no doubt" (Participant 5). Females were expected to be the caterers at department events and one participant said that while she herself is accepting of conventional gender roles, where males and females have specific roles to play, it does become problematic when the same men who expect her

to fulfil her gender roles also expect her to provide the technical backing and knowledge, required of an engineer. Another participant highlighted how males and females in her department interacted separately. The kitchen area in the department became known to her as a 'male area', and any efforts by a woman to enter that area would result in the men changing the topic of conversation or dispersing immediately.

4.5.4 Role of women in engineering

This sub-theme emerged as a reflection of the ideas of the meaning of gender and how the participants saw gender roles playing themselves out in the department. Most of the participants expressed sentiments similar to those of Participant 8 that "Women can bring something else to the table because we think differently um, we really do than men".

Women are more comfortable in an academic setting, but as they are in the minority; they are still the 'other' in comparison to men. The women highlighted how they are more responsible for administrative tasks than the men are. The administrative duties made it difficult for them to find time to focus on research and publications. Consequently, the inability to produce publications and obtain a PhD then creates another challenge in that one is not taken seriously. As Participant 6 stated, "It's hard to be promoted without doing a lot of research". Similarly, Participant 4 said, "If you want to be taken serious, that I realised now after my three years here in academia, you really have to have a PhD".

The women recognised the importance of publishing and qualifications/status in engineering. However, the women seemed to feel that their administrative duties that involved interaction with students provided a platform for women to feel useful and fulfilled. The participants all referred to women being different to men, and contributing differently to the workplace compared to men. There seemed to be a need to justify their presence in engineering. This can be equated to how women work harder in industry in order to prove their capabilities to their male colleagues.

4.5.5 Hiring in academia

Gender in academia was also experienced during the hiring phase of a woman's career. The situation of women as mothers in academia was an issue referred to in many of the interviews. For example, Participant 2 claimed that University officials, "sometimes see family responsibilities as a negative when they employ women. My boss actually he wanted to know if, if I felt that I could manage both [work and home responsibilities]...if I had been a man that wouldn't have come up". However, all participants did acknowledge that the

departments were changing and were beginning to accommodate women and their family roles. As Participant 6 said, “the department’s pretty aware that, you know, if you want to have women, um, and they do, then you have to be prepared that they are going to have babies”.

In terms of promotion in academia, few women had completed and obtained their doctoral degrees, and the general attitude seemed to be that, while there was some pressure to get this done, they were not really too worried about that. There was a sense of complacency among the participants in obtaining their post-graduate degrees. Family was prioritised and the women appeared to be content with the fact that they could be with their families more.

4.5.6 Balancing work life and personal life

The women mentioned that they faced the challenge of balancing their work and personal lives. The male colleagues were seen as being insensitive to the other responsibilities women have. In the words of Participant 9, “the one challenge is that your [male] colleagues think that you can do the same hours they do...they have a wife at home, who makes dinner, cleans the house, the washing...while you still have to do that as well...they don’t understand that”.

4.6 Theme 3: Dealing with challenges

This theme was influenced by the literature and the interview questions asked. This refers to the mechanisms, internal, external, personal, or otherwise that assisted the women to deal with the challenges they faced in their career. This theme is also in relation to what keeps these women in academia and in engineering, specifically. The participants indicated that the engineering profession itself is not a caring profession, which often means that support networks are absent within the profession. One has to look elsewhere among family and friends, or professional psychologists, for such emotional support. Two participants mentioned their use of psychological assistance in order to cope with personal and professional challenges.

4.6.1 Support structures

This sub-theme refers to any mention of support structures, family, friends, colleagues and other forms of support that the participants have found useful in their career, and that have helped them to remain committed to the field. Instead of attempting to change the institutional structures, women adapt to the challenges they face in engineering. Because

the ability to adapt to challenges is encouraged, the alternative to adaptation is associated with weakness.

The participants indicated that support is important to have in their career. According to Participant 4, “I think the support is very important, I don’t know how you do it alone”. Family support was identified as being useful in motivating the women, especially when they encountered challenges that made them feel like they wanted to leave the profession sometimes. The family seems to play a role in encouraging a woman’s choice to take engineering and to follow an engineering career earlier in life. The same family structure however seems to be the determinant of one’s entry into academia and exit from industry. The reasons for entering academia seem to be associated with childbirth or a need to support one’s spouse or partner in their career, at the expense of the woman’s career in engineering.

In terms of collegiate support, the senior participants indicated that they would elicit assistance and support from someone outside of the department. For example, Participant 6 said:

> “The way women often share emotion, connections is through emotional currency, through sharing stories, portraying vulnerability, that kind of weakness, and that is the other thing that is not ok for me to do at work right, and part of that is that it’s a masculine environment so it is not an environment where I would ever, like, have given or got a hug from my advisor because my mom had died”.

The participants seldom made use of collegiate support, instead they elicited support from people outside the department, sometimes even from those within a different faculty. The expression of emotion or the need for support was seen as a sign of weakness and as unacceptable behaviour within a masculine setting. In addition to the rejection of the feminine within the engineering identity, senior participants reported that they did not find their female colleagues supportive. Other women were described as “mean spirited and they gossip and they nag and they are bitchy” (Participant 9) and also “they are more the backstabbers, that’s how I feel” (Participant 4). Female colleagues were not really part of one’s support system, “women don’t support each other, they don’t vote for each other cause they are jealous, men will always vote for men, women will also vote for men” (Participant 9).

The junior participants found both men and women to be supportive. The junior participants valued collegiate support, and looked at the other people in the department as people to learn from, who were always open to help them. All three junior lecturers expressed sentiments similar to those of Participant 7, namely: “The other lecturers because we are still junior lecturers we still have to learn a lot from them and their doors are always open if you want to ask them questions, they are always available”. The support was not gender based. They stated that they could approach both male and female lecturers for support, and that gender was irrelevant. In contrast, older participants mentioned that male mentors are useful to have as a source of support in one’s career. Male mentors were seen as useful to have and as important in one’s career. According to Participant 2, “I had some very good mentors, male mentors, it made a big difference”. The women indicated that while they worked better with men. Having a mentor, male or female, was important in dealing with challenges in one’s career. In the view of Participant 4, “it doesn’t matter if its academia or not, get a mentor and let that mentor help you develop”. The senior participants described their fellow female colleagues in less than positive ways. This can be attributed to a number of things, primarily the inheritance of the culture of engineering as competitive. With few women in the engineering environment, in order to gain a more noticeable status in engineering, the women become selfish with information with fellow women and resort to stereotypical feminine characteristics of gossiping and back-stabbing as a way to deal with their insecurities of being a woman within a masculine space.

4.6.2 Get over yourself

In order to cope within the engineering environment, the participants referred to the need for women to “get over yourself” (Participant 1). All the participants, young and old alluded to the fact that women in engineering need to look beyond themselves and get on with what they need to do. The women said that because they were not the only ones experiencing negativity as women, they had to also look beyond themselves and adapt. For example, Participant 8 said: “All of my friends, girl friends also faced the same problem and we were ok with it...just bear it”. Participant 4 did however mention how, in adapting to the culture when she was in industry, she began to lose her femininity. She commented:

> “....losing my feminine part...Yes and then stop, stop caring for how you look, just if you work in a plant environment, you cannot dress, you have to dress in safety clothes or in practical clothes and so on...I reached a point where I didn’t want to, I for a long time I didn’t wear make-up”.

She attributed this loss of femininity to the workload that she had to deal with, saying: “It’s so much stress; so much work is taking over so much of who you are” (Participant 4).

4.6.3 Be assertive

The general view was that women had to look beyond themselves as has been described previously. However, when asked to give advice to young girls who may want to enter into academia and engineering, Participant 2 said, “You have to assert yourself”. Women who complained about discrimination were seen as deserving of their fate, as they failed to speak up and change things if they were unhappy about them. All six senior participants stated how they had been assertive within the workplace. Participant 9 said:

> “When I joined this department I did, I set out certain cards...this is how it’s gonna [sic] work. There was a little bit of resistance ‘no but you know uh’. I said, listen, I’m only here because I like being here, the moment I don’t like it anymore I’m gone”.

Participant 6 expressed similar ideas saying:

> “When I interviewed for this job I asked specifically in the interview about maternity and family policy so I was very upfront that I was going to be having a baby, you know. So that’s the other thing is to just be, you know, this is who I am I’m going to have a baby I’m going to be a mother...I’ve been very upfront about that in this job”.

4.7 Theme 4: Reasons for staying in academia

4.7.1 Positive experience in academia

The study was conducted with the aim of finding out what reasons women academics in engineering provide for their continued presence and commitment to the field. The participants reflected on their experiences in academia as students and, later, as members of academic staff. As students, the participants indicated that their experiences were generally positive, with exception for some negative experiences during their vacation work training period, as highlighted earlier. The academic environment was described as being safe and fair, with any difficulties being experienced from outside of the working environment.

For instance, Participant 1 stated:

> "Once you have broken through in the community where I am as a faculty member and even when in my previous work, you're accepted and its fine...it doesn't make a difference but as soon as I leave the offices...if you're in a company of like a school meeting with these other moms when you tell them what you do, it's almost as if they are too intimidated to speak to you".

Another participant said: "I don't believe academics see gender to be honest with you" (Participant 5). The gender differences for her were only present in industry when she did her vac work. This was the general sentiment amongst most participants. The experiences within academia itself were: "Very positive" (Participant 1). Some of the participants acknowledged that while their experiences were mainly positive, they were aware that other's experiences may not have been equally as positive.

4.7.2 Few challenges in academia compared to industry

The research endeavoured to gain an understanding of the reasons women in engineering academia provide for their continued commitment to the field. Once again, the idea that academia was a better environment than industry emerged. The participants' experienced academia positively. Although there were a few challenges encountered in engineering academia, there were fewer challenges in academia in comparison to industry. The challenges they faced in academia were minimal, compared to the challenges they would have faced in industry. When asked about the challenges faced as a woman in academia, Participant 5 responded: "As a woman in academia, nothing compares to industry". This kind of reasoning, contributed to keeping these women in engineering academia.

A few challenges experienced in academia include adjusting to academic life and teaching and other academic requirements, such as acquiring funding and publishing. These will be discussed briefly.

4.7.2.1 Adjusting to academia

One participant mentioned that while her overall experience of academia was a positive one, she did struggle to adjust to the culture of academia: "What I found difficult is I worked in...multi-disciplinary teams...at university you're on your own so it's very, very isolated...I find that frustrating" (Participant 4). The isolated nature of engineering academia was also mentioned by another participant (Participant 9). Participant 4 also mentioned the

competitive nature of academia and the difficulties faced in learning to adapt to academic culture: “Its competitive...getting used to the different hierarchies and things, that’s important at university level...emotionally it was very hard for me to deal with many of the things”.

4.7.2.2 Teaching as a challenge

Another challenge that arose from their experiences in academia was that of teaching: “Standing in front of a class I think that was the one thing that overwhelmed me a lot so I think that would be the worst in academia” (Participant 3). The participants attributed this challenge to a lack of experience in teaching itself: “That was really difficult for me...in industry we have this, you do presentations and teaching is something different” (Participant 4).

4.7.2.3 Pressure to publish

All participants mentioned the pressure to produce articles and to obtain a doctoral degree as being a challenge they experienced in academia. Furthermore, the presence of children and family was given by all participants as posing a challenge and as an obstacle to one’s productivity. The women stated that they had no time, as their family responsibilities were a priority for them and this limited their ability to carry out their research. Participant 5 mentioned that if she did not have family responsibilities, she would be producing the same amount of publications as the men produce. In her words:

> “I think that if I wasn’t married working as an academic here, I probably would be doing just as much output as the men but I think it’s because I’m married and I’ve got a child at home and I’ve got those inherent roles instinctive roles I’ve got to manage that’s the reason why”.

4.7.2.4 Funding as a challenge

Research output is only possible if one has access to sufficient funding. Although family responsibilities were identified by the senior participants only as a challenge, the problem of obtaining funding was mentioned by both the junior and senior participants: Participant 4, one of the senior participants said, “one of the...challenges in academia is funding, to get funding”. Participant 7, one of the junior participants, when asked about the challenges faced in academia, said, “if you want to attend a conference or you, yeah, [you need] to get funding from the NRF, but that’s basically the only thing”. The access to funding appears to be a problem experienced by most women academics in engineering.

4.7.3 Passion for teaching and the students

Despite the challenges experienced, in responding to the question of what keeps them in academia, almost all the participants mentioned their passion for teaching and the students as essential factors keeping them in academia. As discussed previously, a passion for teaching was also a reason for entering engineering academia for two of the nine participants. However, the majority of participants (five of the nine participants) indicated that this passion emerged once they began to teach. For example, Participant 9, who had resisted requests from University management for her to lecture in her department for almost ten years, realised when she began teaching that she enjoyed it. She said: “I started liking the undergraduate students...I find that contact very conducive to my own creative ability so what will keep me here will be the third years” (Participant 9).

4.7.4 Ability to make a difference

The passion for teaching and for the students appeared more among the senior participants, and was hardly mentioned by the more junior participants (Participant 7 and Participant 8). The attachment to the students was coupled with the feeling that the participants could “see that you make a difference, the ability to make a difference, a real difference” (Participant 1). Also, the women felt that they dealt with the students in a different way, compared to their male counterparts, and that they developed a deep emotional connection with the students. The participants were aware that they had most of the teaching and administrative duties, but they indicated how they enjoy the students.

The women in the study appeared to accept their engendered roles and viewed their ability to connect with the students as an indication that they are an asset to the department. In fact, the feminine is experienced as a positive aspect and as a necessary attribute within the field, justifying women’s presence in it. Through teaching, the participants felt that they were making a difference to the lives of the students they taught. Teaching gave them a sense of fulfilment.

4.7.5 Role of HOD

This sub-theme describes the role of the head of department as a supportive individual and someone who the participants experienced as being a contributing factor to their level of comfort in academia and, as such, as a reason for their remaining in the department and in academia.

All the participants referred to their head of department (manager) as being supportive and as a role model. Participant 1 said “my head of the department is very supportive, very supportive especially in terms of the work-life balance, family balance he’s been supportive...although there’s pressure on him, I think he keeps it from me”. In addition to providing the much-needed support, the head of department was one of the reasons the participants remained in engineering. All participants referred to their respective heads of departments as accommodating, understanding, and as creating an environment which contributed significantly to the positive experiences of the participants in academia. In the absence of a formal mentoring programme, the head of department became the role model, the mentor and the support system. The senior participants seemed to value their ability to be creative with their research focus, something that is seen as not present in industry. The head of department was seen as fundamental in cultivating this creativity. Participant 6 said: “[He’s/She’s] comfortable with other people doing different choices and doing things in different ways”.

4.7.6 Flexibility and relaxation of academia

This theme refers to the ideas that emerged that expressed the experience of the academic environment as flexible, in comparison to industry, and as more accommodating of women with children. In addition, the environment was described as being relaxed.

All the participants mentioned that a motivating factor to remain in academia was the flexibility if offered them. When asked what keeps her committed to academia, Participant 5 said: “The flexibility it offers me, pure and simple, that is the major reason”. Other participants expressed similar sentiments. A younger participant who at the time of the interview had no children saw academia as a good place to work when she has children in the future: “Its much more flexible if, if you one day want to have children, it’s a much more flexible environment” (Participant 3). Overall, the academic environment offered the participants the flexibility they required.

Embedded in the flexibility was the more accommodating nature of the management at the University that included the heads of department, and the Dean of the School of Engineering. Engineering academia was described as being accommodating of personal circumstances in comparison to industry. This is what keeps some of the women in academia, as some of the participants mentioned that if their circumstances were different, they may have remained in industry. For example, Participant 9, who owns her own business, said: “In academia there’s more openness, flexibility, uh, a better

understanding...there's more personal space here". This flexibility made it possible for her to manage her company responsibilities as well as her academic responsibilities; something she would not have been able to do if she had remained in industry.

Another participant reported that she had the same workload in academia as she would have had in industry, for a lower salary (Participant 5). The difference was that in academia, she could attend to her personal responsibilities when she needed to, as academia was less stringent in terms of the hours one needed to be present at work. The participants perceive academia as more accommodating of the personal lives of its employees.

4.7.7 Environment and space

Finally, only two participants referred to the space in which their job is located as a positive factor that makes them stay in academia. Participant 4 said:

> "The working environment is very nice. If I walk from my car to my office, I'm walking through the botanical gardens every morning and every afternoon. It's wonderful and it's also the fact that there is, I don't know, I can go to an art exhibition. There's art exhibitions frequently. There's music frequently, you know, there's different things yeah, so that is, that I really enjoy".

In her turn, Participant 9 stated: "The nice - I know the lawns not so nice now - but the nice lawn and trees, the beautiful buildings" was something that she appreciated.

4.8 Conclusion

This chapter highlighted the themes and sub-themes identified by the researcher during analysis of the transcriptions. Participants' responses were extracted from the transcriptions, verbatim, to substantiate the themes described. The next chapter will provide a discussion and further interpretation of the themes, as they provide answers to the research question of the study.

Chapter 5: Discussion of findings and conclusion

5.1 Introduction

This chapter provides a discussion of the themes and sub-themes identified in Chapter 4. The themes are discussed and interpreted in relation to the research question and the literature review that was carried out in Chapter 2. To conclude the chapter, limitations of this study will be discussed and recommendations for future research will be provided.

5.1.1 Discussion of themes and sub-themes

Analysis refers to the process by which a researcher reduces data to a story with interpretation provided. According to Kawulich (2004), during analysis, data is organized and then reduced, summarized and categorised into identified themes. Categories reflect the purpose of the research and should ideally be exhaustive and mutually exclusive (Kawulich, 2004). Creswell (2003) states that the researcher should make sense of what the data reveals in order to provide an understanding of the phenomenon under investigation.

The discussion of the themes and sub-themes to follow will be based on the researcher's interpretation of the data, as influenced by the literature review in order to answer the research question of the study.

5.2 Reasons for entering academia

The opportunity to further one's education was a reason provided by the participants, for choosing an academic path. As highlighted in Chapter 2, there are few women in engineering academia. Although there has been an increase in the enrolment of females at undergraduate level, very few women pursue postgraduate qualifications (Shackleton et al., 2006). In this study, the women who returned to academia were pursuing their postgraduate degrees, while most of their male colleagues were already in possession of their doctoral qualifications or professorial titles. The participants alluded to the fact that, while there was a large amount of information provided for working opportunities in industry, they were unaware of opportunities to study further until they enquired about them. The lack of access to information is in accordance with the findings by Monhardt et al. (1999) that women were unaware of information that may have assisted them in advancing their careers (see Chapter 2). Therefore, it is probable that making information on academia available to young female engineers may result in increase in female postgraduate enrolments.

Furthermore, the participants decided to enter academia due to the challenges they faced in industry, particularly for women with children. According to Sheridan (1995), there is no indication that women with children are less productive than men. However, women with children are viewed as a liability in industry (Sheridan, 1995). Institutional structures and rules are formulated on the assumption that engineers have no other responsibilities. There are no structures in place that accommodate women and their dual roles as mothers and career women, and this forces women with children to leave industry. Entry into academia is a result of the unaccommodating nature of industry.

5.3 Gender and Engineering: experiences in the workplace

Literature on women in engineering highlights how engineering is a male-dominated and masculine field (Davis, 2001; Sagebiel, 2007; Sheridan, 1995). The women who survive in engineering discard their feminine attributes and take on more masculine characteristics (Davis, 2001; Delisle et al., 2009; Good et al., 2008; Kandiyoti, 1988). However, Faulkner (2000) argues that instead of a complete rejection of their femininity, women in engineering create new versions of their gendered identity. Ultimately, a re-adjustment of their femininity is necessary in order for a woman to function optimally in engineering (Faulkner, 2000).

5.3.1 Industry vs. academia: Industry as a gendered space

Society expects women to be responsible for the household and family (Barinaga, 1994). Social attitudes promote the idea that men are breadwinners and not childminders (Sheridan, 1995). In addition, institutions do not have policies towards childcare that are accommodating of women and their need for flexible working hours (Barinaga, 1994). The current study revealed that industry has no provision in place for the time women may need to carry out their socially prescribed roles, as highlighted by Barinaga (1994).

Furthermore, institutional structures that require all engineers, male or female, to be at work for long periods of time mean that women are at a disadvantage within the workplace (Davis, 2001). It appears from the findings that both industry and academia continue to work on the assumption that one's physical presence within the workplace is the only way to ensure high levels of productivity (Naidoo, Smit & Seedat-Khan, 2011). Naidoo et al. (2011) investigated the issue of gender and work-family dynamics of men and women in academia. In their study, they raised the question of whether or not one's physical presence in the office is an accurate indicator of working hard and high productivity (Naidoo et al., 2011). They questioned whether the concept of office attendance should begin to change, given the advances in technology and the fact that the home space has begun to be an extension of

the workplace, as academics increasingly complete or carry out work at home (Naidoo et al., 2011).

The findings of this study also reveal that for women to exist in engineering, the status of an engineer, and not just as a woman in engineering, has to be earned. Proving one's competence has been accepted as a normal process by the women in engineering. Essentially, failure to prove one's worth as an engineer to the men in the engineering environment results in one's alienation from the status of an engineer. In order to earn 'engineer' status, the women adopted a new engineering femininity as Faulkner (2000) predicted. The women's engineering status became their only identity within the engineering setting. These findings support the findings by Davis (2001) that men are the gatekeepers of the engineering profession. Furthermore, as stated in Chapter 2, women in engineering are forced to participate in a gendered power system where their position as women is not acknowledged (De la Rey & Kottler, 1999).

5.3.2 Academia as accommodating

In contrast to industry where women transition from being 'women' to becoming 'engineers', with the two identities treated as separate entities, the two identities co-exist in academia. Women in engineering academia assume an engineering identity, but they also maintain their identities as females, and switch between the two within the workplace. The academic workplace allows them to embrace their social roles as women within the working space. The participants brought their households into the workplace in different ways, including bringing their children to the office in the absence of suitable childcare at home, taking the day off when a family emergency arises and making explicit to the head of department what responsibilities outside of the workplace they have. In academia, the total individual appears to be taken into consideration. The office space is not just a place of business; it is also a space where personal lives appear regularly.

Policies and practices in the academic environment assume that members of faculty are not primary caregivers (Stewart et al., 2007). The academic institution works on the premise that faculty members rely on other people to take care of family and household responsibilities (Stewart et al., 2007). Although academia offers some flexibility, the women reported that they still faced some difficulties in balancing all aspects of their life. Institutional polices need to recognise women's care giving responsibilities and allocate resources to support them and their male colleagues who have similar responsibilities (Stewart et al., 2007).

There is an indication that women in engineering do experience their gender as being a factor in their career, in both industry and academia. Although the women in the study felt accepted by the males in their different departments, the experiences of being the 'other' to their male colleagues indicated the presence of gender categories in engineering. As highlighted in Chapter 1, gender influences how women in engineering experience and deal with the challenges they face in the field (Finchilescu, 2006). Despite the participants' efforts to portray engineering academia as free of gender bias, gender is present at all times in engineering as in all institutions (Faulkner, 2000). The participants' repeated assertions that engineering is, in fact, free of gender discrimination indicate that the women may employ denial as a coping strategy. There is a sense of agency in such denial. It is essentially a choice to accept the status quo and remove oneself and one's experience from the gendered messages that are present as a way to deal with them (Chowdhury et al., 2007; Faulkner, 2000; Kandiyoti, 1988).

5.4 Dealing with challenges

As highlighted in Chapter 2, where challenges were faced, particularly for women with children, women had to find ways of tackling their problems (Davis, 2001). The culture of the engineering department resembles the culture of industry as masculine and intolerant of weakness. Being an engineer is at all times an acceptance and conformity to masculine identities (Faulkner, 2000). The women in the study appear to have accepted the masculine nature of engineering; they temporarily removed themselves from their gender and recreated a new engineering identity within the workplace. As Faulkner (2000) argues, all these measures facilitate women's ability to cope and function within engineering.

5.5 Reasons for staying in academia

Women's ability to deal with the challenges they face in engineering is one reason for their continued commitment to the field. In addition to these coping strategies, the participants experienced the academic environment positively, in comparison to industry. The challenges in academia were perceived to be minimal in comparison to the challenges that they said they would have faced in an industry setting. The challenges faced by women, as discussed in Chapter 2, are some of the reasons why women opt out of engineering industry (Davis, 2001). Academia then becomes their next career option. According to Chowdhury et al. (2007), women in engineering require more flexibility, few overtime hours, and good mentorship in order to be successful. Academia offers women these things and becomes more attractive in that regard for women with household responsibilities.

However, women still hold junior positions and tertiary institutions remain White and male dominated (Du Toit & Roodt, 2009; Perumal, 2003). The flexibility and freedom experienced by these women serve as hindrances to promotion opportunities within academia. The administrative and teaching duties women are allocated limit the time they have to carry out research. Furthermore, as the women are in academia for the flexibility it offers, their interest in academic achievements and promotion is a secondary goal. In the United States, almost 60% of women in the SET sector, had aspirations of following an academic career after graduation (Frehill, 2007). In South Africa, the trend seems to be for females to want to be in industry, with a few exceptions. Industry offers higher remuneration than that offered by academia. For the younger participants, academia serves as a required, stepping-stone towards a career in industry. For the senior participants, academia is a safe-haven for women with children when industry no longer affords them the flexibility they need to be mothers, wives and professionals. Incentives need to be in place in academia that will make it a first choice for a career path for women and not a last resort when industry fails them.

Networks of support and role models are positive factors, to encourage women to advance in their careers in engineering (South African Council for Scientific and Industrial Research, 2006). The participants found their family and friends as being supportive. Support from fellow female colleagues was minimal and was often experienced negatively. The participants did acknowledge that in order for one to be able to find their way in engineering, the presence of a role model is essential (South African Council for Scientific and Industrial Research, 2006). There are few female role models in academia (Chowdhury et al., 2007). The absence of female role models is due to the low numbers of women faculty members in the discipline (Frehill, 2007). The senior participants mentioned that they found mentorship from male colleagues, as women, difficult to work with. The preference for male mentors and role models further perpetuates the idea that men are the gatekeepers of science (Davis, 2001). However, the current study revealed that the younger participants found mentorship from both male and female colleagues. The younger participants sought assistance from an individual as determined by his or her expertise, and not by gender.

According to Frehill (2007), departmental heads shape the climate of the department. It is apparent that the head of department is important in both the recruitment and retention of women engineers in academia. However, the head of department cannot continuously be the single source of support for all members of staff. There is a noticeable lack of support from other colleagues within one's department, particularly among the senior participants. A formal mentoring programme, that pairs junior members of staff (in terms of qualifications),

with Professors and Assistant Professors (Frehill, 2007) may ensure that all members of staff have access to support and the benefits associated with this support (Barinaga, 1994). Support structures will provide women with information on how to access funding for research, and the unwritten rules of engagement in evaluation procedures that women are often not aware of (as highlighted in Chapter 2) (Frehill, 2007; Sheridan, 1995).

Finally, a passion for teaching and for the students was also indicated as a reason for one remaining in engineering academia. Research on women in engineering academia does indicate a passion for the students as contributing to one's job satisfaction (Chowdhury et al., 2007). However, most research does not focus on the teaching of engineering. Women in engineering academia are engineers first and their teaching is in relation to their status as engineers. Therefore, the teaching of Engineering is an area that requires further research.

5.6 Summary

The reasons for women's continued presence and commitment to engineering academia include the flexibility academia offers. Academia is experienced as a more accommodating and flexible environment for women with household responsibilities. The passion for students appears to develop on the job, and further contributes to the decision to remain in academia. The findings reveal that women's family and household responsibilities are not only a priority, but they also significantly influence women's career choices. The ability to accommodate women's personal lives within the workplace influences the recruitment and retention of women in engineering academia. However, the commitment to academia is present for as long as industry remains rigid and unaccommodating of women's roles. Strategies to retain women in engineering academia need to offer competitive incentives that will make academia a first career choice.

5.7 Limitations and researcher's reflections

The method of research may have influenced the findings of the study. Qualitative research allows the participant to freely talk about their experiences. However, the use of an interview guide may have impacted on the experiences that the women revealed. The use of a different method of gaining information may have revealed different stories. My ability as a researcher may have impacted on the entire research process. As this study was my first personal research endeavour, my limited research skills impacted on my data collection. As the interviewer, I had to remind myself not to ask leading questions and to engage in a conversation while allowing the participant to express their experiences.

Furthermore, my position as the researcher, a young, Black, female, psychology student may have influenced the responses I received during the interviews. In particular, I noticed the participants were uncomfortable with referring to racial issues in detail, possibly because of the difference in race between the participants and me. In addition, my position as the researcher inevitably had an impact on my interpretations of the findings. Although the participants checked for accuracy of the transcripts, the final analysis was primarily my own. My interests in women and gender issues and the politics of gender relations meant I was inclined towards finding evidence of women's oppression in engineering (Stanley & Wise, 1983), something which I had to remain aware of at all times. I had to remember to separate my own ideas about gender from the analysis. The women's ideas seemed to reveal an acceptance of existing gender norms, which I equated with denial and this could possibly be denying the women their own agency in the situation.

The participants were all White, females, from Afrikaans cultural backgrounds. The experiences they revealed may have reflected their own standing as White women in a post-apartheid South Africa where they feel Black people are at a significant advantage in the workplace. Feminist standpoint theory argues that the individual's position within a context reveals a situated knowledge (Hekman, 1997). Therefore, the findings may have been different if other races and more women were included in the study. Furthermore, the idea of female homogeneity in engineering also becomes problematic, as there are varying identities and experiences among the White females in engineering academia. Nonetheless, feminist theory acknowledges that there are multiple standpoints of knowledge. The absence of other racial categories among the participants was due to the fact that engineering departments at the University of Pretoria are occupied mostly by White females (Note: One woman of Indian/Asian race was identified in the sampling frame, but did not match the selection criteria as she was not in a teaching post).

The location of the research was also a limitation. The research was carried out in a single location, familiar to the researcher. The researcher's affiliation with the institution facilitated entry into the institution and was convenient due to budget and time constraints. However, the findings may be a reflection of University of Pretoria academic culture and this may have been different if the location of the study were broader. Furthermore, because there are few women in engineering academia (Maree & Maree, 2007), the anonymity of the participants may easily be compromised even though every effort was made to ensure this did not occur. The participants may have been reluctant to be completely truthful with their responses, which may explain why they spoke positively about their academic experience. The question

asking the participants for advice for young girls who may want to become engineers was posed in anticipation of this. It was a challenge to get the women to be open and truthful about their experiences of an institution in which they are still members.

Another limitation was the use of literature from countries in the 'global north', such as the United States of America and the United Kingdom. Use of such ideas to describe phenomena in the 'global south' and South Africa, in particular, is problematic, particularly as social and cultural context is important in assessing women's experiences.

All these limitations provide insight that may be useful for similar studies in the future. A different methodology may reveal different findings and provide more insight into the experiences of women in engineering academia.

5.8 Recommendations

This study contributes to the knowledge surrounding women in engineering academia in South Africa. The findings reveal that, while women in engineering academia have managed to adapt to the requirements of the profession, they do continue to face some challenges. The recommendations provided in this section are ideas formulated by the researcher and are aimed at ensuring the retention of women in engineering academia, as informed by the findings of this study

The participants mentioned that women should be assertive in the workplace in order to survive. Some participants mentioned the help they received from professional psychologists and from peer-support groups. According to Sagebiel (2007), "characterising the reward of individual merit [is] a myth as it hides the tacit help or support and recognition of men's male peers and mentors" (p. 151). Fostering a culture of open and honest discussion of challenges faced will allow all members of a department to become aware of the challenges as a first step in addressing them. In addition to this, the establishment of a formal mentoring programme which pairs students and junior staff members with senior staff who have already obtained professorial titles (Davis, 2001; Frehill, 2007) will ensure that women receive the necessary support in their career.

The low numbers of women with professorial titles is due to the limited publications women produce (Sheridan, 1995). Encouraging women to participate in joint research projects, either with their male peers, or among themselves as women, may address the problem. The sharing of research work will allow the women to remain visible in the field through publications while they attend to their other administrative or household responsibilities. This

requires a change of the culture of engineering as an isolated arena (Participant 9) to a new communal culture emphasising the benefits of teamwork. Furthermore, recognition of the gendered, societal divisions of labour that impose childcare and household responsibilities on women more than on men, would contribute to changing academic culture. Institutional structures need to make provisions for individuals' personal life within the workplace. Women, more than men, require flexibility and mentoring to thrive (Chowdhury et al., 2007). Also, the administrative and other duties women carry out need to be recognised as valuable and be taken into account when promotions are deliberated. According to Sagebiel (2007), institutions cannot continue to judge women under standards of a 'normal male' employee as this ignores women's other responsibilities. The standards of evaluation need to take into account societal obstacles that may not allow women to participate on par with their male counterparts.

Finally, while society prescribes household and childcare responsibilities for women, the women appear to both embrace and despise these roles. The culture of engineering academia is such that for one to excel in their profession, other social responsibilities should become secondary. Women prioritise family because they feel it is the right thing to do, despite their awareness of what such choices may mean for their careers. There needs to be a change of social norms to allow women to accept that getting help with childcare and other household duties is acceptable. Women's identity need not be associated with childcare first. A fluid transition between the different roles they play as wives, mothers, and as professionals should be possible.

5.9 Conclusion

This study is an example of feminist research, as the voices of women were brought to the fore. Feminist research provides a starting point for future research. This study revealed the experiences of nine women in engineering academia at one institution, the University of Pretoria's School of Engineering. The racial composition of the different departments within engineering resulted in only White participants being involved in the research.

As a small sample participated in the study, the knowledge acquired can be used to inform other research. Future research needs to pay attention to the experiences of women from different racial categories, in order to arrive at an understanding of their standpoint in engineering academia. Furthermore, a broader scope of research areas at provincial, regional or national level may also reveal new knowledge on women in engineering academia. Finally, as this study aimed to contribute to retention strategies for women in

engineering, a study analysing existing strategies of retention may provide insight into what strategies are working and how they can be made better.

References

Aronson, J. (1994). A pragmatic view of thematic analysis. *The Qualitative Report, 2*(1), 1-3.

Assiter, A. (2000). Feminist Epistemology and Value. *Feminist Theory, 1*(3), 329–45.

Barinaga, M. (1994). Overview: surprises across the cultural divide in comparisons across cultures, and science. *Science, 263*, 1467-1496. doi:10:1126/science.8128232

Bos, W., & Tarnai, C. (1999). Content analysis in empirical social research. *International Journal of Educational Research, 31*, 659-671.

Braidotti, R. (2003). Feminist philosophies. In M. Eagleton (Ed.). *A Concise Companion to Feminist Theory* (pp. 195- 214). London, United Kingdom: Blackwell Publishing.

Burck, C. (2005). Comparing qualitative research methodologies for systemic research: The use of grounded theory, discourse analysis and narrative analysis. *Journal of Family Therapy, 27*, 237-262.

Case, J., & Jawitz, J. (2004). Using situated cognition theory in researching student experience of the workplace. *Journal of Research in Science Teaching, 41*(5), 415-431.

Cech, E.A. (2007). Dilbert in stilettos: The character of deterrents facing women in engineering. In I. Welpe, B. Reschka & J. Larkin (Eds.). *Gender and Engineering: Strategies and Possibilities* (pp. 35-50). Frankfurt am Main: Peter Lang.

Chowdhury, F., Hoo, K., & Pasik-Duncan, B. (2007). Innovative strategies for retention of women engineers in academia: Conversation with successful role models. In I. Welpe, B. Reschka and J. Larkin (Eds.). *Gender and Engineering: Strategies and Possibilities* (pp.137-148). Frankfurt am Main: Peter Lang.

Coetzee, D. (2001). South African education and the ideology of patriarchy. *South African Journal of Education, 21*(4), 300-304.

Creswell, J. W. (2003). *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches*. Thousand Oaks, CA: Sage.

Cronin, C., & Roger, A. (1999). Theorizing progress: Women in science, engineering, and technology in higher education. *Journal of Research in Science Teaching, 36*(6), 637-661.

D'Cruz, H.; Gillingham, P., & Melendez, S. (2007). Reflexivity, its meanings and relevance for social work: A critical review of the literature. *British Journal of Social Work, 37*, 73-90. doi:10.1093/bjsw/bc1001

Dane, F. C. (1990). *Research Methods*. Pacific Grove, CA: Brooks Cole.

Davis, K.S. (2001). "Peripheral and subversive": Women making connections and challenging the boundaries of the science community. *Science Education, 85*, 368-409.

De la Rey, C., & Kottler, A. (1999). Societal transformation: Gender, feminism and psychology in South Africa. *Feminism Psychology, 9,* 119-126. doi:10.1177/0959353599009002002

De la Rey, C., Jankelowitz, G., & Suffla, S. (2003). Women's leadership programs in South Africa: A strategy for community intervention. *Prevention and Intervention Practice in Post-Apartheid South Africa,* 49-64.

Delisle, M.N., Guay, F., Senecal, C., & Larose, S. (2009). Predicting stereotype endorsement and academic motivation in women in science programs: A longitudinal model. *Learning and Individual Differences, 19*, 468-475.

Denzin, N.K., & Lincoln, Y.S. (Eds.). (2005). *The SAGE Handbook of Qualitative Research.* London: Sage Publications.

Devers, K.J., & Frankel, R.M. (2000). Study design in qualitative research-2: Sampling and data collection strategies. *Education for Health, 13*(2), 263-271.

Diale, M., Buchner, S.J., Buthelezi, Z., Gledhill, I.M.A., Grayson, D.J., & Kgabi, N.A. (2009). Women in physics in South Africa: the story to 2008. *Paper presented at the Women in Physics, The 3rd IUPAP International Conference on Women in Physics.* American Institute of Physics. doi: 10.1177/0959353599009002002

Dryburgh, H. (1999). Work hard, play hard: Women and professionalization in engineering-adapting to the culture. *Gender & Society, 13*(5), 664-682.

Du Toit, R., & Roodt, J. (2009). *Engineers in a Developing Country the Profession and Education of Engineering Professionals in South Africa*. Cape Town: HSRC Press. Retrieved from: http://www.hsrcpress.ac.za/product.php?productid=2252&cat=1&page=1.

Esler, K.J., Shackleton, L., & Chinsamy-Turan, A. (2006). SAWISE and HERS-SA: Raising the profile of women in science. *South African Journal of Science, 102*, 275-276.

Faulkner, W. (2000). Dualism, hierarchies and gender in engineering. *Social Studies of Science, 30*(5), 759-792.

Finchilescu, G. (2006). Women as a minority group. In F. Boonzaier, T. Shefer and P. Kiguwa (Eds.). *The Gender of Psychology* (pp. 85-99). Cape Town, South Africa: UCT Press.

Flick, U. (2009). *An Introduction to Qualitative Research.* (4th ed.). London, United Kingdom: Sage Publications.

Forje, J.W. (2008). Book review: Women in science, engineering and technology: Three decades of UK initiatives. *Africa Insight, 38*(2), 139-141.

Fox, M.F. (2010). Women and men faculty in academic science and engineering: Social-organizational indicators and implications. *American Behavioural Scientists, 53*(7), 997-1012.

Francis, M.M. (2009). *Women in engineering: Identifying and analyzing gender socialization in the Faculty of Engineering at the University of Kwa-Zulu Natal*. Master's thesis, University of South Africa.

Frehill, L. (2007). The ADVANCE: Institutional transformation program's impact on engineering schools. In I. Welpe, B. Reschka and J. Larkin (Eds.). *Gender and Engineering: Strategies and Possibilities* (pp. 225-244). Frankfurt am Main: Peter Lang.

Garforth, L., & Kerr, A. (2009). Women and science: What's the problem? *Social Politics: International Studies in Gender, State & Society, 16*(3), 379-403. doi:10.1093/sp/jxp015

Gergen, M. (2001). *Feminist Reconstructions in Psychology: Narrative, Gender and Performance*. London, United Kingdom: Sage Publications.

Glover, J. (2001). Targeting women: Policy issues relating to women's representation in professional scientific employment. *Policy Studies, 22*(2), 69-82.

Godin, B. (2007). What is science? Defining science by the numbers, 1920-2000. *Project on the History & Sociology of S&T Statistics: Working Paper No. 35*, 1-56.

Good, C., Aronson, J., & Harder, J.A. (2008). Problems in the pipeline: Stereotype threat and women's achievement in high-level math courses. *Journal of Applied Developmental Psychology, 29*, 17-28.

Graneheim, B., & Lundman, U.H. (2004). Qualitative content analysis in nursing research: Concepts, procedures and measures to achieve trustworthiness. *Nurse Education Today, 24*, 105-112.

Gravetter, F.J., & Forzano, L.B. (2009). *Research Methods for the Behavioural Sciences* (3rd ed.). Belmont, CA: Wadsworth Cengage Learning.

Groenwald, T. (2004). A phenomenological research design illustrated. *International Journal of Qualitative Methods, 3*(1), 1-26.

Guenther, K.M. (2009). The politics of names: Rethinking the methodological and ethical significance of naming people, organizations and places. *Qualitative Research, 9*(4), 411-421. doi:10.177/1468794109337872

Gupta, N., & Sharma, A.K. (2003). Gender inequality in the work environment at institutes of higher learning in science and technology in India. *Work, Employment & Society, 17*(4), 597-616.

Harding, S. (2004). Introduction: Standpoint theory as a site of political, philosophic and scientific debate. In S. Harding (Ed.). *The Feminist Standpoint Theory Reader: Intellectual and Political Controversies* (pp. 1-15). USA, New York: Routledge.

Harding, S.G. (1986). *The Science Question in Feminism.* Ithaca, New York: Cornell University Press.

Hekman, S. (1997). Truth and method: Feminist standpoint theory revisited. *Signs, 22*(2), 341-365.

Hill-Collins, P. (1997). Comment on Hekman's "Truth and method: Feminist standpoint theory revisited": Where's the power? *Signs, 22*(2), 375-381.

Holloway, I., & Wheeler, S. (2002). *Qualitative Research in Nursing.* (2nd ed.). Malden: Blackwell Publishing.

Hopkins, P.E. (2007). Thinking critically and creatively about focus groups. *Area, 39*(4), 528-535.

Hove, S.E., & Anda, B. (2005). *Experiences from conducting semi-structured interviews in empirical Software Engineering research*. Paper presented at the 11th IEEE International Software Metrics Symposium, Convo, Italy.

Jawitz, J., Case, J., & Tshabalala, M. (2000). Why not engineering? The process of career choice amongst South African female students. *International Journal of Engineering and Education, 16*(6), 470-475.

Jonasdottir, A.G. (1988). Sex/gender, power and politics: Towards a theory of the foundations of male authority in the formally equal society. *Acta Sociologica, 31*(2), 157-174.

Kalabamu, F. (2006). Patriarchy and women's land rights in Botswana. *Land Use Policy, 23,* 237-246.

Kandiyoti, D. (1988). Bargaining with patriarchy. *Gender and Society, 2*(3), 274-290.

Kawulich, B.B. (2004). *From interview to results: The processes of analysis.* Paper presented at the 6th International Conference on Logic and Methodology, Amsterdam, Netherlands.

Keifer, A., Sekaquaptewa, D., & Barczyk, A. (2006). When appearance concerns make women look bad: Solo status and body image concerns diminish women's academic performance. *Journal of Experimental Social Psychology, 42*, 78-86.

Keller, E. F. (1992). *Secrets of Life, Secrets of Death: Essays on Language, Gender and Science*. New York: Routledge.

Lamphere, L. (2006). Bringing the family to work: Women's culture on the shop floor. In E. Lewin (Ed.). *Feminist Anthropology: A Reader* (pp. 222-234). Malden, MA, Oxford: Wiley-Blackwell Publishing.

Langdridge, D. (2007). *Phenomenological Psychology: Theory, Research and Method*. London, United Kingdom: Pearson Education Limited.

Lips, H. M. (2005). *Sex & Gender An Introduction* (5th ed.). McGraw-Hill Companies Inc.

Longino, H.E. (1993). Feminist standpoint theory and the problems of knowledge. *Signs, 19(*1), 201-212.

Lynd, L. (n.d). A perspective on engineering and its relationship to systems analysis and science. *Engineering Science 22*.
Retrieved from
http://wwwdartmouth.edu/~sullivan/22files/Engineering_vs._science.pdf.

Maree, D., & Maree, M. (2007). Assessing the impact of gender training on engineering students. In I. Welpe, B. Reschka and J. Larkin (Eds.). *Gender and Engineering: Strategies and Possibilities* (pp. 191-211). Frankfurt am Main: Peter Lang.

Mc Clure, J.W. (2007). International graduates' cross-cultural adjustment: Experiences, coping strategies, and suggested programmatic responses. *Teaching in Higher Education, 12*(2), 199-217.

Mc Laughlin, J. (2003). *Feminist Social and Political Theory: Contemporary Debates and Dialogues*. New York: Palgrave Macmillan.

McKiernan, M., & McCarthy, G. (2010). Family members' lived experience in the intensive care unit: A phenomenological study. *Intensive and Critical Care Nursing, 26*, 254-261.

Monhardt, R.M., Tillotson, J.W., & Veronesi, P.D. (1999). Same destination, different journeys: A comparison of male and female views on becoming and being a scientist. *International Journal of Science Education, 21*(5), 533-551.

Moore, P. (2006). Book reviews. *Signs: Journal of Women in Culture & Society*, 1155-1158.

Naidoo, K., Smit, R., & Seedat-Khan, M. (2011). *Gender and Work-Family Dynamics: Exploring 'Exclusion' in the Academy*. Paper presented at the South African Sociological Association XVII Congress, Pretoria, South Africa.

National Advisory Council on Innovation. (2009). *Facing the facts: Women's participation in science, engineering and technology*. South Africa: National Advisory Council on Innovation.

Nauta, M.N., Epperson, D.L., & Waggoner, K.M. (1999). Perceived causes of success and failure: are women's attributions related to persistence in engineering majors? *Journal of Research In Science Technology, 36*(6), 663-676.

Organization for Economic Cooperation and Development. (2011). Strategies for a global workforce. *Workshop on Women in Science, Engineering and Technology (SET),* Ontario, Canada. Retrieved from http://www.oecd.org/document/15/0,3343,en_2649_34269_37361295_1_1_1_1,00.html.

Ohman, A. (2005). Qualitative methodology for rehabilitation research. *Journal of Rehabilitation Medicine, 37,* 273-280.

Pawley, A.L. (2004). The feminist engineering classroom: A vision for future educational innovations. *Men and Masculinities, 6*(4), 383-403.

Perumal, J. (2003). Identifying and responding to barriers impacting women educators: Reflections of educators on institutional constraints. *SAJHE/SATHO, 17*(1), 74-82.

Pillow, W.S. (2002). Gender matters: Feminist research in educational evaluation. *New Directions for Evaluation, 96*, 9-26.

Reed & Case (2003). Factors influencing learners' choice of mechanical engineering as a career. *African Journal of Research in SMT Education, 7*, 73-83.

Riley, D., Pawley, A.L., Tucker, J., & Catalano, G.D. (2009). Feminism in engineering education: Transformative possibilities. *NWSA Journal, 21*(2), 21-40.

Ritchie, J., & Lewis, J. (Eds.). (2003). *Qualitative Research Practice: A Guide for Social Science Students and Researchers*. London, United Kingdom: Sage Publications.

Rosser, S.V., & Taylor, M.Z. (2009). Why are we still worried about women in science? *Academe, 95*(3), 7-10.

Royal, K., & Mamaril, N. (2008). Women and minorities in engineering: A review of the literature. *All Academic Research*. Retrieved from http://www/allacademic.com/meta/p_mla_apa_research_citation/2/7/3/4/3/pages273438/pages273439.php.

Sagebiel, F. (2007). Gendered organisational engineering cultures in Europe. In I. Welpe, B. Reschka and J. Larkin (Eds.). *Gender and Engineering: Strategies and Possibilities* (pp. 149-174). Frankfurt am Main: Peter Lang.

Sargent, R.W.H. (2002). Danckwerts memorial lecture: Engineering science or scientific engineering? *Chemical Engineering Science, 57*(7), 1075-1077.

Shackleton, L., Riordan, S., & Simonis, D. (2006). Gender and the transformation agenda in South African higher education. *Women's Studies International Forum, 29*, 572-580.

Shadish, W. R., Cook, T. D., & Campbell, D. T. (2002). *Experimental and Quasi-Experimental Designs for Generalized Causal Inference.* USA, Boston: Houghton Mifflin.

Shaw, I.F. (2003). Ethics in qualitative research and evaluation. *Journal of Social Work, 3*(1), 9-29.

Sheridan, B. (1995). "Strangers in a strange land": A literature review of women in science. *CGIAR Gender Program, Working Paper, 17.* Retrieved from http://www.genderdiversity.cgiar.org/.../genderdiversity_WP17.pdf.

Siepmann, J.P. (1999). Editorial: What is science? *Journal of Theoretics, 1-3*, 1-3.

Small Business Project. (2011). *Tertiary education costs and other barriers affecting the entry of female students to tertiary education: Science, engineering and technology degrees*. Draft Report to the National Advisory Council on Innovation.

South African Council for Scientific and Industrial Research. (2006). Women in science. *Science Scope, 1*(4), 1-44.

South African Reference Group. (2004). Facing the facts: Women's participation in science, engineering and technology. *Science, Engineering and Technology for Women*. Pretoria, South Africa: National Advisory Council on Innovation and the Department of Science and Technology.

Sprague, J. (2005). *Feminist Methodologies for Critical Researchers: Bridging Differences*. London, United Kingdom: Alta Mira Press.

Stanley, L., & Wise, S. (1983). *Breaking Out Again: Feminist Ontology and Epistemology*. London: Routledge.

Stewart, A., Malley, J.E., & LaVaque-Manty, D. (2007). Analyzing the problem of women in science and engineering: Why do we need institutional transformation? In A. Stewart, J.E. Malley and D. LaVaque-Monty, (Eds.). *Transforming Science and Engineering: Advancing Academic Women* (pp. 3-20). Ann Arbor, MI: University of Michigan Press.

Stoetzler, M., & Yuval-Davis, N. (2002). Standpoint theory, situated knowledge and the situated imagination. *Feminist Theory, 3*(3), 315-333.

Tongco, M. D.C. (2007). Purposive sampling as a tool for informant selection. *Ethnobotany Research and Applications, 5*, 147-158.

University of Pretoria. (2010). *School of Engineering*. Retrieved November 15, 2010, from: http://web.up.ac.za/default.asp?ipkCategoryID=1031&subid=1031&ipklookid=7

University of Pretoria. (2011). Human Resources Department: Organisation development. Accessed: 10 March, 2011. Retrieved March 10, 2011, from: http://web.up.ac.za/default.asp?ipkCategoryID=3230&subid=3230&ipklookid=14&parentid=

Wajcman, J. (2004). *TechnoFeminism*. Cambridge: Polity Press.

Webb, B. (2002). Using focus groups as a research method: A personal experience. *Journal of Nursing Management, 10*, 27-35.

Wilbur, W.J. (2002). Thematic analysis of AIDS literature. *Pacific Symposium on Biocomputing, 7*, 386-397.

Young, D. (2004, January 12). Women vastly underrepresented in academia. Women in Science. *E-news.org*. Retrieved from http://www.womensenews.org/story/women-in-science/040112/women-vastly-underrepresented-in-academia.

Appendix A: Semi-structured one-on-one interview guide

Personal and demographic information

1. Name, age and racial identity
2. Number of years in academia
3. Relationship status (single, married, co-habitating); number of children if any
4. Position in the department/faculty and general job responsibilities

Questions

5. Can you provide a description of how you ended up in engineering and in this position?
6. Why did you decide to enter into academia?
7. What is your understanding of the term ‘gender’?
8. How do gender relations play themselves out in the faculty/department?
9. What has your experience been as a woman in engineering?
10. What challenges, if any, have you encountered (if none, then what challenges do they think other women face in engineering)?
11. How have you (or other’s) dealt with these challenges?
12. How have others around you, personal and professional, impacted on your ability to overcome these challenges?
13. With the challenges faced what keeps you committed to your career in this field?
14. What would you say are the most essential factors that keep you in engineering (explanation of each)?
15. Do you have anything else you wish to talk about regarding your experiences in engineering?