Women's Representation in STEM Related Education and Careers:

A Case Study of Female University Students in Saudi Arabia.

Thesis Submitted for the Degree of Doctor of Philosophy at Staffordshire University, United Kingdom

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December 2018

ACKNOWLEDGMENTS

Education is a blessing and appreciating the enormity of the treasures it encompasses, is to understand that it is a gift to be shared. I am grateful to God Almighty for this wonderful gift, the opportunity to complete this PhD study and inspire others to pursue their ambitions.

To my supervisors, Professor Tehmina Basit and Dr Lynn Machin heartfelt thanks for guiding me every step of the way, with an abundance of patience and expert advice. I couldn't have achieved this without you. Many thanks to Dr. M.D Asaduzzaman for his valuable guidance on my quantitative data analysis. To the students and faculty members who participated in this study, thank you for sharing your insights and experiences. Your contribution made this research study possible. I hope that you achieve your dreams and keep on rising to new heights. Sincere thanks to the administrators who helped with the execution of my research.

To Staffordshire University, our partnership began in 1984 and is crowned with this PhD, many thanks to all those who have been part of my educational success. Completing three degrees in one university is not merely a sign of loyalty but it is a testimony to the quality of education and remarkable efforts expended to empower students.

It is an honour to have been a welcomed guest in Saudi Arabia for many years. This study is close to my heart as is every girl that I have ever taught. Thank you, for in your own ways you have steered me towards this PhD, a different direction for the one I envisaged. Yet, one which combines my passion for education and STEM.

Often PhD students mention the loneliness of their journey, but on the contrary, I have so many people to thank for sharing my expedition, for encouraging my aspirations, believing in me and inspiring me. Some are no longer with me, yet their impact remains the same; my daughter Amirah Shadia Bashir, my greatest inspiration and my father Samuel Thomas, my first teacher. To my amazing mother, Evelyn Thomas who constantly encourages me to reach for the stars. There are no words that express my gratitude for your endless love and support. A huge thank you to my children Asbati, Amir and Fatima, who have developed immense patience during this period, and my siblings, my extended family and friends who have constantly believed that my best is good enough. Thank you, your continuous support is truly appreciated.

Last, but not least my dear husband, friend and mentor Dr Bashir Muhammad Sani. Your critical analysis of my research and the subsequent intellectual debates were invaluable. Thank you for supporting my dream, for all the prayers and for the gentle reminders to persevere. Your contribution has been tremendous, and I am truly grateful.

ABSTRACT

Predicted skills shortages in Science, Technology, Engineering, and Mathematics (STEM) have caused global concerns regarding skills shortage and economic competitiveness. Evidence suggesting flaws in this prediction have not deterred the implementation of numerous initiatives to attract untapped human capital to STEM careers. Women have been identified amongst the underrepresented groups in STEM education and careers; however, the drive to increase their representation has yielded minimal success. Consequently, the underrepresentation of women in STEM education and careers has developed into an issue of gender equality, particularly in secular societies. This study explores the representation of women in STEM education and careers in an Islamic country, Saudi Arabia, which has a distinctive gender-segregated society, one reinforced by cultural, religious, and social norms. This study also examines the influences on girls' decisions to pursue STEM education and careers by employing a mixed methods approach that focuses on the lived experiences of the participants.

Questionnaires were administered to 352 female participants in one public university. Out of these, 312 were foundation year STEM track students (FYS), 30 were third year STEM students (TYS), and 10 were university faculty members (FM). Analysis of the survey data revealed that students' aspirations for STEM careers begins as early as grade 4; the favourite school subject is mathematics; and the most desired profession is medicine. Semi-structured interviews were conducted with a sample of 35 participants: FYS (20), TYS (10), and FM (5). Analysis of the qualitative data revealed that girls do not experience subject-related gender stereotypes in public schools. Nevertheless, whilst they are empowered to study all science subjects, only the most academic can follow the science track in high school and university. It was also evident that career education in Saudi Arabian schools is inadequate and students rarely receive careers guidance in school, although they receive unparalleled encouragement and support from their parents and extended family.

The findings of this study gave empirical support to Giddens' Structuration Theory. It reveals that social and cultural transformations are commonplace within female-only and family spheres, where the agentic actions of girls are enabled and, subsequently, lead to their empowerment within them. Yet, this study also demonstrates that, oftentimes, working women themselves contribute to the reproduction of social structures. It highlights the fact that the high uptake of Saudi women in STEM education in Saudi Arabia is not replicated in the labour market. The contribution of Saudi female STEM graduates has largely been constrained by the shortage of jobs for women, and cultural norms that prioritise family responsibilities. It is evident that structures in the public sphere are generally reproduced, and when transformations do occur, they are the result of government endorsements. This is a pivotal time in the lives of Saudi Arabian women, as the current structural changes outlined in the 2030 vision encourage the participation of women in the workforce. However, the swiftness of cultural changes may be dependent on individual and familial structures and aspirations. This study recommends strategies for increasing the autonomy of school teachers and principals, and for developing students' early interest in STEM subjects. Furthermore, it recommends the introduction of effective career education programs into schools and the involvement of parents in initiatives to equip students with knowledge, about possible careers and the labour market, prior to entering high school.

Abbreviations

ARAMCO	Arabian American Oil Company
CAA	Centre for Academic Assessment
CDSI	Central Department of Statistics and Information
CEDAW	Convention on the Elimination of All Forms of Discrimination Against Women
CSW	Commission on the Status of Women
ECOSOC	Economic and Social Council
EFA	Education for All
FLL	First Lego League
FM	Faculty Members
FYS	Foundation Year Students
GAT	General Aptitude Test
GCC	Gulf Cooperation Council
GCSE	General Certificate of Secondary Education
GGGI	Global Gender Gap Index
GPA	Grade Point Average
GPGE	The General Presidency of Girls' Education
HDRF	Human Resource Development Fund
HRW	Human Rights Watch
HS	High School
ILO	International Labour Organisation
ITA	International Trade Association
KACST	King Abdallah City for Science and Technology
KAUST	King Abdallah University of Science and Technology
KASP	King Abdullah Scholarship Program
KSA	Kingdom of Saudi Arabia
MENA	Middle East and North African

MIT	Massachusetts Institute of Technology
MBBS	Bachelor of Medicine, Bachelor of Surgery
MDG	Millennium Development Goals
MoE	Ministry of Education
MoHE	Ministry of Higher Education
MoLSD	Ministry of Labour and Social Development
MSPI	Mawhiba School Partnership Initiative
NCES	National Centre for Educational Statistics
NDP	The National Development Plan
NSF	National Science Foundation
OECD	The Organisation for Economic Cooperation and Development
PISA	The Programme for International Student Assessment
PBUH	Peace be upon him
PMU	Princess Miya University
SAAT	Standard Achievement Admission Test
SDG	Sustainable Development Goals
SET	Science, Engineering and Technology
SES	Socio-Economic Status
SPSS	Statistical Package for Social Sciences
ST	Structuration Theory
SST	Strong Structuration Theory
STEM	Science Technology Engineering and Mathematics
STEMM	Science Technology Engineering Mathematics and Medicine
TYS	Third Year Students
TIMSS	Trends in Mathematics and Science
UN	United Nations
UNESCO	The United Nations Educational, Scientific and Cultural Organisation
UKRC	United Kingdom Resource Centre

UK	United Kingdom
USA	United States of America
WISE	Women in Science and Engineering

TABLE OF CONTENTS

List of Tables

List of Figures

Chapter One

1. Introduction

1.1 Background to the Study

The United Nations Commission on the Status of Women (CSW) was established in 1946, to monitor the situation of women and to promote women's rights (ECOSOC, 2010). It was instrumental in highlighting the areas in which women are denied equality with men and continues to operate globally. Several declarations later, the resolutions of the Convention on the Elimination of All Forms of Discrimination against Women (CEDAW) was adopted on December 18, 1979 by the United Nations General Assembly. It created a universal standard for women's human rights, addressing discrimination in areas such as education, employment, marriage and family relations, and healthcare (OHCHR, 1979). CEDAW entered into force as an international treaty in September 1981 and has since been ratified by 187 countries (OHCHR, 2013). Interestingly, the USA is the only democracy that has not ratified CEDAW. As a signatory to the treaty, the USA indicated its preliminary endorsement of the instruments, but conservative and right-wing religious groups strongly opposed the ratification of CEDAW (Koh, 2002; Lowen, 2017). These groups believe that:

> CEDAW rejects the true basis of equality, namely, that men and women are equally created …. with distinct physical, psychological and other characteristics. The unique God-given, functions or abilities of males and females, based on these inherent distinctions …. are not inconsistent with this true equality (Jacobson, 2007:2).

The conservatives later reaffirmed their stance and sparked opposition to the ratification of CEDAW by the liberal democrats (Schast, 2014; de Silva de Alwis and Martin, 2018). CEDAW's advocacy of reproductive rights and gender-neutral work rules (Al Shraideh, 2017; Lowen, 2017), are strongly opposed because of the belief that eradicating gender roles threatens American family life not only for women but for everyone (Ramdas and Janus, 2011). Advocates of the treaty contend that American laws already fall in line with the goals of the treaty, therefore, the actions and decisions of the CEDAW committee would not affect the private lives of American citizens (Schast, 2014). This refusal by a developed nation to ratify CEDAW was particularly poignant to the international community, as it indicated the lack of commitment from the USA to enforcing women's rights. Schast (2014) argues that the USA is

reluctant to subject itself to international standards that other countries appear to disregard without any consequences. Thus, pointing to countries with ostensibly less impressive gender equality practices than the USA who have ratified the treaty. Amongst them is Saudi Arabia, with its perceived disempowerment of women, who ratified CEDAW with reservations based on religious considerations that were not factored into and recognized in the convention (Buang and Suryandari, 2017). These religious considerations appeared to be comparable with the concerns of the USA, as the Holy Quran clearly states in Chapter 4 (Women):

> O mankind! Be careful of your duty toward your Lord who created you from a single soul and from it its mate, and from them both have spread abroad a multitude of men and women. Be careful of your duty toward God in Whom you claim (your rights) of one another, and towards the wombs (that bore you). Lo! God has been a Watcher over you (Quran 4:1).

The Arabian Peninsula is characterized by secular perceptions of gender inequality (Moghadam, 2003; 2004). However, secular and religious perspectives on gender equality are not always aligned and international rights documents tend to be based on secular views (Runzo, 2014). According to Al Sadi and Basit (2017), secular notions of gender equality are concerned with human rights and democratic stances, whilst, for Muslim women, religion is integral to their views (Badran, 2013). Nonetheless, a comprehensive definition of gender equality has not been constructed that allows it to be measurable; consequently, gender equality is often incorrectly equated to gender parity, i.e. equal numbers of women and men (D'Orville, 2010). Although achieving parity in numbers is important, true gender equality must also combat the bias and imbalance in practices that encourage stereotypical gender roles (Al Sadi and Basit, 2017). Discourse to combat gender inequalities has been significant in several global development programs; for example, the United Nations Millennium Development Goals (MDGs) that were established in 2000, were set for 2015 (United Nations, 2008). The third MDG was to promote gender equality and empower women, but was not achieved by any country. Consequently, gender equality is currently goal number 5 of the United Nations 2030, Sustainable Development Goals (SDGs) (United Nations, 2017a). This suggests the difficulty in global achievement of gender equality. Despite the targets set out in these gender equality initiatives, it is estimated that it will take between 100 and 217 years for all countries to achieve numerical gender equality:

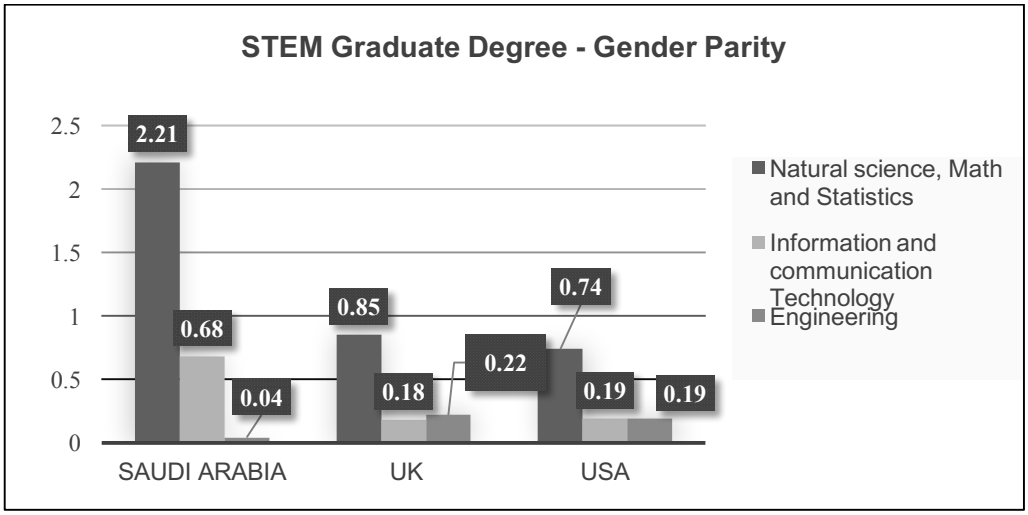
> On current trends, the overall global gender gap can be closed in exactly 100 years across the 106 countries covered since the inception of the *Report*, compared to 83 years, last year [2016]. Given the continued widening of the economic gender gap, it will now not be closed for another 217 years. However, the education–specific gender gap could be reduced to parity within the next 13 years (World Economic Forum, 2017: viii).

Saudi Arabia currently ranks 138 out of 144 countries for gender parity, an improvement compared to its rank of 141 out of 144 countries in 2016 (World Economic Forum, 2016). Additionally, significant progress has also been reported as the country reduced its gender gap in enrolment in primary education and some progress in gender parity for professional and technical workers. Over the past decade, Saudi Arabia has recorded the region's largest improvement on the overall Index. On Educational Attainment, it is the fifth-most improved country in the world (World Economic Forum, 2017).

Education is considered one of the most powerful instruments for achieving gender equality (Malik, 2013). CEDAW Article 10(c) makes specific reference to coeducation "The elimination of any stereotyped concept of the roles of men and women at all levels and in all forms of education by encouraging coeducation…" (OHCHR, 1979). The notion that coeducation is a vehicle to achieving gender equality is problematic, particularly since research has consistently recognized that gender profiles related to subjects persist in co-educational schools (Fryer Jr and Levitt, 2010; Archer *et al.*, 2017b). Additionally, the ongoing debate of single-sex education versus co-education is inconclusive, with differential benefits according to gender (Patterson and Pahlke, 2011; Pahlke *et al.*, 2014). Fryer Jr and Levitt (2010) argue that coeducation could have adverse effects on educational attainment of girls who are accustomed to and comfortable in gender segregated educational environments like those in some Middle Eastern countries.

The findings of the Global Gender Gap report (World Economic Forum, 2017) support previous research that indicates that women in several countries are strongly under-represented in Engineering, Manufacturing and Construction, and Information, Communication and Technology (World Economic Forum, 2017). A closer examination of the STEM data on graduates by degree type show that Saudi Arabia has one of the highest percentages of science graduates (OECD, 2016) and a higher gender parity than many countries, including the UK and the USA in all STEM fields, excluding engineering. This is outlined in figure 1.1, which I have developed based on data from the Gender Gap Report (Gender Gap Report, 2017). It also illustrates the overrepresentation of Saudi female graduates in natural sciences, maths, and statistics.

Figure 1.1 Gender Parity based on STEM Graduate Degrees



Nevertheless, the OECD report (2016) notes that Saudi Arabia has the largest gender gap in employment rates at all levels of educational attainment, across all OECD and partner countries (Alsubaie and Jones, 2017), indicating that higher levels of education do not necessarily lead to higher employment rates for women in the labour market (OECD, 2017).

Globally science, technology, engineering, and mathematics (STEM) fields are considered the accelerating forces for future economic growth (Rothwell, 2013). STEM knowledge, critical thinking, and technical skills can also be transferred to a wide variety of careers (Science and Technology Committee, 2017). Projected labour workforce figures indicate that by 2020 there will be insufficient skilled STEM workers to fulfil science and engineering jobs in the USA (Sargent Jr, 2017) and there are particular skills shortages in sectors that depend on STEM subjects in the UK (Science and Technology Committee, 2017). The reported STEM skill shortages in the UK, USA, and several countries has given rise to educational policies, careers guidance and diverse initiatives to stimulate interest in STEM fields among young people (Sargent Jr, 2017). These measures, however, failed to increase the uptake of STEM subjects among young people (Banks and Sokolowski, 2010; Morgan *et al.*, 2016). The STEM skills shortage discourse is current, and strategic efforts to solve the problem have been directed to certain groups who are underrepresented in STEM fields, particularly ethnic minorities and women. The contending need to increase women in the STEM workforce is further compounded by the goal of achieving gender equality. Consequently, despite the presence of women in the STEM workforce in the UK and USA, these countries are falling short of the gender equality goals. Thus, the underrepresentation of women in the STEM workforce has been the focus of numerous studies. The current study adds to this body of literature.

This chapter is divided into nine sections. The following three sections set the context of this study and review Saudi Arabia's demographic, cultural, political and economic status with the economic reform, which is rapidly changing the landscape for Saudi Arabian citizens and specifically Saudi women. The subsequent sections discuss the introduction of education in Saudi Arabia and women's rights. This is followed by theoretical underpinnings and rationale for the study. The final section then outlines the structure of the thesis.

1.1.1 Saudi Arabia's Demographics and Culture

Saudi Arabia was established as a kingdom on September 23rd, 1932, when Abdul Aziz Al Saud was proclaimed King of Saudi Arabia (Hamdan, 2013; Pavan, 2013). It is the largest country in the Middle East, with an area of 2,250,000 sq. km, occupying 80% of the Arabian Peninsula. Most of the terrain consists of Arid desert and mountains. Saudi Arabia is bordered by the Red Sea to the west and the Persian Gulf to the east. Neighbouring countries are the United Arab Emirates, and Qatar on the east; Kuwait, Iraq and Jordan to the north, Yemen and the Sultanate of Oman to the south. Bahrain is connected to Saudi mainland by a causeway (UN Statistics Division 2015).

Saudi Arabia is divided into 13 provinces. Riyadh, located in the central province, is the capital city of Saudi Arabia. It is the high-tech centre of modern Saudi Arabia and houses the headquarters of the Gulf Cooperation Council (GCC). It is also the location of Princess Nora bint Abdulrahman University (founded in 2007), the world's largest university for women only, with an enrolment of over 52,000 undergraduate and graduate students. Islam's two holiest cities, Makkah and Madinah are in Saudi Arabia, where Islam was born in the sixth century and where Islam's holy book, The Quran, was revealed (AlMunajjed, 2009). Makkah is the birthplace of the Prophet Muhammad, peace be upon him (PBUH), and the focal point of the annual Islamic Pilgrimage, Hajj, where approximately two million Muslims from all parts of the world participate (Smith, 2017b). Madinah is the city to which Prophet Muhammed (PBUH) emigrated.

Figure 1.2 Map of Saudi Arabia (Henderson, 2009)

Jeddah is located along the Western Coast of Saudi Arabia. It is the commercial capital of Saudi Arabia and serves as an entrance to the rest of the peninsula. Jeddah's ports are the main route for trade. The twin industrial cities of Jubail and Yanbu are a symbol of the government's vision of Saudi Arabia's future development (Al-Harbi, 2017). Jubail lies on the Arabian Gulf in the Eastern Province of the Kingdom, and it is an ancient centre and caravan junction famous for its pearl industry. Jubail also has the world's largest petrochemical complex. Al-Dammam has the largest port on the Arabian Gulf. The Haramain Express Train project, a railway that connects the regions of Makkah and Madinah through Jeddah, is set to be fully operational in 2018. It will have a vital role in the transportation of the growing number of pilgrims who visit the holy sites, as well as visitors and residents who visit Makkah and Medina during the year. It is expected that the annual transport volume for the project will exceed three million passengers annually (Railway Technology, Railway Gazette, 2016).

The population of Saudi Arabia in 2017 was approximately 33 million, with about 40% under the age of twenty-five (Blanchard, 2017; United Nations, 2017b). The life expectancy in Saudi Arabia has dramatically increased from 52.7 years in 1970 to 75.05 years in 2015. Over this 45-year period, a number of widespread health and education reforms occurred. The government prioritized the modernization of medicine and quality of physician training (MoFA, 2017). Saudi Arabia's nationwide educational system comprises 26 government universities, more than 24,000 schools, and many colleges, and other educational and training institutions.

The system provides students with free education and books. The government allocates over 25% of the total budget for education including vocational training and spends around 13.17 billion US dollars on all education, and educational research. Whereas, only 8 percent of the adult population of Saudi Arabia was literate in 1970, by 2014, this had increased to over 94.4 per cent by United Nations standards (MoFA, 2017).

1.1.2 Political Development

Saudi Arabia's status in the Islamic world is very strong and has led to an increase in its participation in international relations. Unlike many other Gulf countries, Saudi Arabia did not experience colonial rule. Consequently, rather than building on a legacy of foreign institutional structures, laws and norms that could be adapted or rejected (Bendix, 2017), it created its own structures, laws and norms, which were a fusion of Islamic law and cultural (tribal) practices (Al Lily, 2011). Saudi Arabia is considered as the 'keeper' of the Islamic religion, but with that title comes a great deal of responsibility including the preservation of the Muslim religion (Baki 2004). The King's official title is, Custodian of the Two Holy Mosques, Makkah and Madinah (AlMunajjed, 1997). Executive, legislative, and judicial powers are exercised by the King and the Cabinet also known as the Saudi Council of Ministers (Al-Rushaid, 2010). The Cabinet is chosen by the King. The government draws on the Holy Quran and the Sunnah as the country's constitution. Legislation must be ratified by royal decree and be compatible with the kingdom's interpretation of Sharia law. Sharia is the basis of Saudi law, governing both civil and criminal justice, as well as regulating an individual's moral conduct.

Since the death of the founder of modern Saudi Arabia, King Abdulaziz Al Saud, in 1953, succession of the Saudi throne, the absolute monarchy has been passed on successively to his sons, a system that raised questions about the future as the brothers aged. The current Custodian of the Two Holy Mosques Salman bin Abdulaziz, the 6th king of Saudi Arabia ascended the throne on January 23rd, 2015, succeeding his brother Abdullah bin Abdulaziz. Concerns that King Salman, who is portrayed as a religious conformist would roll back or limit the reforms implemented during the reign of King Abdallah to promote women right's in Saudi society (Spencer, 2016) were overshadowed when he overturned decades of royal custom and profoundly reordered the kingdom's inner power structure (Hubbard, 2017). King Salman named his son, Prince Mohammed bin Salman, Deputy Crown Prince in 2015, and then Crown Prince in June 2017, the first time since the ascension that succession will pass from father to son rather than brother to brother (Hubbard, 2017). Crown Prince Mohammed bin Salman has been the driving force behind liberal reforms in Saudi Arabia. These include lifting the driving ban on women, re-introducing various forms of public entertainment, such as cinemas and

concerts, and outlining plans for the futuristic megacity named Neom (Farag, 2018). The implementation of his initiatives has been swift since the launch of the 2030 Vision, which aims to engage 30% of Saudi women in the workforce (Kinninmont, 2017).

1.1.3 Economy

Saudi Arabia is one of the richest countries in the world because of its oil revenues, which account for approximately 90% of the state budget (Index Mundi, 2017). Saudi Arabia is rich in raw materials such as sand, limestone, and clay, and producing industries based on dates and fishing. The economy of Saudi Arabia was altered dramatically when oil was discovered in 1938. Towns became cities, Bedouins departed deserts, and many fishermen in the eastern and western parts of Saudi Arabia started working for the Arabian American Oil Company (ARAMCO) and other related companies (Jones, 2017).

During the oil boom of the 1970s, Saudi Arabia was unable to meet the demand for a skilled workforce, which resulted in the recruitment of highly qualified foreign workers (Al-Asfour and Khan 2014; Alfawaz *et al.*, 2014; Yusuf, 2014). During the same era, Al-Asfour (2014) notes that the local workforce was concentrated in fulfilling public sector jobs. Yet, despite the realization by the Saudi government that they could not sustain providing government jobs to Saudi citizens indefinitely, little was done to address the situation. According to the Saudi Arabian Central Department of Statistics and Information (CDSI), approximately one third of the population are foreign (United Nations, 2012; Hamdan, 2013; CDSI, 2015). This indicates a critical situation, as most Saudi citizens are very young; 80% of the population is under the age of thirty. Alfawaz *et al.* (2014) and Yusuf (2014) attribute the dependence on foreign workers to the unfocussed nature of education received by the large number of Saudi students graduating from institutes of higher education. In 2003, the Saudi Manpower Council mandated that the number of foreign workers and their families should not exceed 20% of the total population by 2013 (Pakkiasamy, 2004). This marked the introduction of Saudization (localization) (Al-Dosary and Rahman, 2005).

1.1.3.1 Saudization

Currently, 7.7 million jobs are filled by foreigners (General Authority for Statistics, 2018). The increased number of foreign workers in Saudi Arabia and the shortage of job opportunities for Saudi citizens has pressured the Saudi government to take swift measures to reduce its negative impact on Saudi citizens who seek employment (Al-Asfour and Khan, 2014; Alshanbri *et al.*, 2015). The term ‘Saudization’, officially known as the Saudi nationalization scheme, refers to a development strategy to train Saudi citizens to replace foreign workers. Saudization

policies have evolved through the years to include specific focus on the economic participation of women (Koyame-Marsh, 2017). However, Fakeeh (2009) has argued that Saudization as a policy has been targeting unemployment rather than employability, which she suggests is the real problem. The poor alignment between the education system in Saudi Arabia and labour market situations (Fakeeh, 2009) is compounded by the ambiguity of skills required for STEM jobs (Mellors-Bourne *et al.*, 2011). This skills mismatch appears to be a global issue (Smith and Gorard, 2011; Weber, 2014; Rathelot and van Rens, 2017; Science and Technology Committee, 2017).

Despite government initiatives, Yusuf (2014) maintains that young Saudis are reluctant to work for private sector employers because the government had previously guaranteed public-sector positions for its citizens. Public sector jobs in the gulf region offer attractive benefits, higher salaries, and shorter working hours than the private sector (Marmenout and Lirio, 2014). Saudi graduates linger in unemployment awaiting job opportunities offered by the government (Al-Asfour and Khan, 2014). This resembles the patriarchal bargain in the United Arab Emirates noted by Williams *et al.* (2013), where fathers encourage their daughters to pursue higher education on the understanding that they will seek employment in the public sector. This suggests that a change in attitude towards private sector employment is critical in increasing the participation of citizens and particularly women in the workforce (Williams *et al.*, 2013). Over 50 per cent of Saudi university graduates are women, and the Kingdom endeavours to develop their talents, invest in their productive capabilities, enable them to strengthen their future, and contribute to the economy and society (MoFA, 2017).

1.1.3.2 The National Development Plan

The National Development Plan (NDP) is a framework of five-year plans first initiated in 1970 by the Saudi Arabian Ministry of Economy and Planning. This was the first attempt to formally make decisions concerning the utilization and allocation of resources for development objectives, focusing mainly on infrastructure investment (Gallarotti, 2013). In the ninth five-year plan (2009-2014) the budget was $385 billion, of which 50.6% was allocated to human resource development, including education and training. The plan targeted increasing the capacity of schools at all levels, and higher education institutes, in addition to allocating grants for research projects and centres in association with King Abdallah City for Science and Technology (KACST) (Al-Rushaid, 2010). The ninth NDP highlighted the Saudi Arabian government's perspective that investing in education has the potential to produce an improved knowledge economy. The human capital theoretical model suggests that educational gains should be related to labour market opportunities. However, investments in education for girls

may not lead to an increase in the size of the labour force if the benefits of education accrue mostly in the home (Lincove, 2008). Saudi Arabia is utilizing the human capital theoretical model to facilitate economic development (Schultz 1961; Becker 1975; Johnes 1993). A significant challenge was to overcome social attitudes to women working and citizens anticipating public sector jobs (Barnett, 2015). The tenth NDP (2015-2019) made specific reference to both enhancing science and technology (Wiseman *et al*., 2017a) and developing the knowledge capacities of national manpower in terms of education, production, and skills (Oxford Business Group, 2015).

1.1.3.3 Saudi Vision 2030

The current Crown Prince, Mohammed bin Salman has led the development of a plan, Saudi Vision 2030, that seeks to, decrease the country's dependence on oil, diversify its economy, and loosen some of the conservative, Islamic kingdom's social restrictions (Nurunnabi, 2017; Payne, 2017). At the heart of Vision 2030 is a society where citizens will enjoy quality of life, a healthy lifestyle, and expanded cultural opportunities. The initiatives currently underway also recognize the role of Saudi women in the economic, political, and social development of the Kingdom. Saudi Arabia's Vision 2030 sets the target of increasing women's participation in the workforce from 22 to 30 percent (Al-Saud., 2016). However, the rising number of Saudi women graduating from universities currently exceeds the number of jobs available, leaving 30% unemployed. Therefore, the implementation of women-orientated labour laws is an effort to address the dichotomy between the Saudi women's education and economic participation (Koyame-Marsh, 2017).

Hubbard's (2017) concerns about the change in succession and fast pace of reforms are mirrored by the more conservative Saudis but are welcomed by the younger generation whose prospects are set to improve. This change in succession in part reflects the hopes of Saudis, as argued a few years ago by House (2012). Most Saudis seek change, though they do not want democracy. Instead, they want a government that provides basic services; a government less corrupt and more transparent in how it spends its annual oil revenue; a kingdom ruled by law, not royal whim (House, 2012). Still, despite the speed with which the official decisions could potentially free up women's lives, the culture shifts more slowly (Hubbard and Alsultan, 2017). The next section of this chapter outlines the establishment of formal education for girls in Saudi Arabia less than 60 years ago.

1.1.4 The Education System

Queen Effat Al-Thunayan, the wife of King Faisal bin Abdulaziz Al Saud, established Taif Model School for boys and girls, in 1943 (Weston, 2011; Younus, 2012). Boys and girls were educated separately but in the same school. Her own children and children of other members of the Al Saud family attended the school. She was an active supporter of education reforms and started several different private educational institutes in Jeddah and Riyadh (Younus, 2012). Immigrants from Indonesia and Malawi established the first private girls' school in Makkah in 1945. Prior to the implementation of public schooling in Saudi Arabia, some parents allowed their daughters to attend informal kutab schools where they learned to read the Quran from a female or a blind male teacher of religion. The daughters of the wealthy were often educated in their own homes by tutors; some were privy to a foreign education, which they received most commonly in Egypt (Al Rawaf and Simmons, 1991).

Al Rawaf and Simmons (1991) provide an insight into the development of girls' education in Saudi Arabia by tracing the history from its inception until 1988. The Saudi government first addressed girls' education in 1959. By royal decree, a committee, The General Presidency of Girls' Education (GPGE), was established for new and existing schools, which would uphold the beliefs, behaviour, and customs of Saudi Arabia, with Muslim teachers teaching the pupils. Saudi Arabia is the only Islamic country that still has a separate and unique system for male and female education (El-Sanabary, 1994; Al-Saif, 2013). The GPGE was established in 1960, and education of females began formally with its first public girls school opening in the same year. The girls were taught the same curriculum as the boys, with the addition of Home Economics and child rearing.

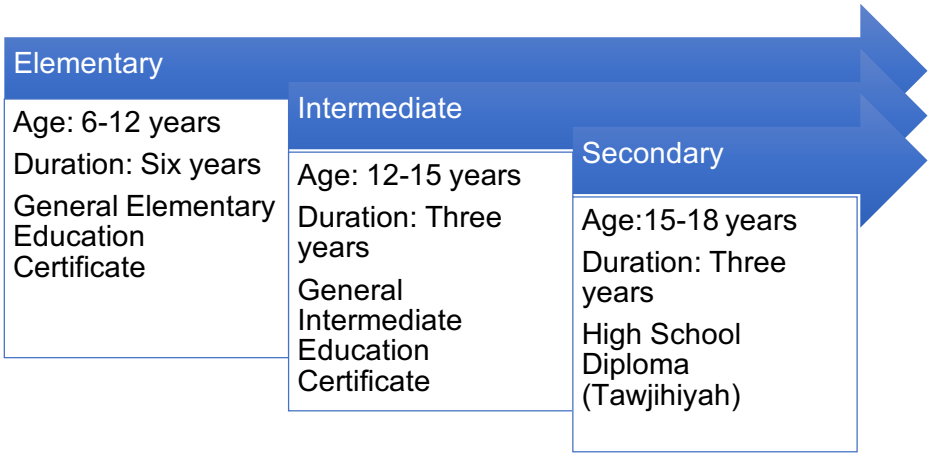
According to Farmer (1971), in a few instances, schools opened under military protection, as some conservative family members who believed that education would corrupt the girls and weaken their faith, went armed to close the schools (Hamdan, 2005). The initial reluctance from the more conservative parents had little effect because, despite some difference in opinion about how profitable education was for women, there was nearly a consensus that education for women was an Islamic duty, as well as a government responsibility (Parveen, 2014). Alghamdi and Hassan (2016) acknowledge that education in Saudi Arabia has progressed tremendously since the 1960s, resulting in advancing the country and its citizens in several areas.

In 1973, King Abdel Aziz University in Jeddah and King Saud University in Riyadh both opened their doors to women, creating separate sections for them. Prior to that, in the 1970s, women

could only obtain a Saudi university degree by distance learning (Corbyn, 2009). Education was not compulsory; however, the oil boom of the 1970s enabled the construction of new buildings to cater for a new generation of young educated mothers who also wanted their daughters to be educated (Al Rawaf and Simmons, 1991). The oil surplus enabled women's education and welfare services (Jones, 2017), but their marginalization and exclusion from the workforce continued to imply that women staying at home became a symbol of wealth (Le Renard, 2008; Al-Rasheed, 2013; Le Renard, 2014). Additionally, Jones (2017) argues that a threat to the elite status of the American company's carefully constructed labour hierarchy by employing educated Arab women resulted in a decision which would reinforce gender inequality and introduce racial inequality. Thus, rather than liberate Saudi women, as they had initially decided was one of their roles, the company supported the education of women but indirectly barred their access to many careers (Jones, 2017).

Today, the Ministry of Education governs all aspects of state funded education in Saudi Arabia. Public and private schools and universities in Saudi Arabia are gender segregated at all levels, except King Abdallah University of Science and Technology (KAUST), the country's only co-educational university (Corbyn, 2009). All public schools follow the government curricula; national private schools have options to follow international curricula in addition to specific subjects as prescribed by the Ministry of Education, Islamic Studies, Arabic Language, and Social Studies (Oxford Business Group, 2015). The language of instruction in public schools is Arabic and English Language is introduced as a subject in grade 6. Progression from one grade level to the next requires successful completion of assessments and examinations. All education and books in government institutions are free for students (Onsman, 2011).School education is divided into three levels, with successful students continuing into higher education, if desired:

Figure 1.3 School Education Levels



1.1.4.1 Elementary Education

Elementary level schooling is compulsory in Saudi Arabia and is also regarded as the foundation for the development of an overall educational program. The school year consists of two semesters, each with at least 15 weeks of classes and a two-week examination period. Grades 1-4 are exempted from these examinations and are instead regularly evaluated by their teachers. The standard curriculum of mathematics, history, Islamic education, fine arts, geography, science, Arabic language, home economics for girls, civics, and physical education for boys is studied by boys and girls in separate schools.

1.1.4.2 Intermediate Education

Although it is not mandatory, students are encouraged to continue their education at this level after completing the elementary level, with the curriculum comprising the same subjects as in the elementary level. Additionally, English Language becomes a required subject and remains compulsory throughout secondary school as well. Passing a completion examination is necessary to receive the Intermediate School Certificate, which is a prerequisite for entering secondary school. Students who pass this educational level obtain an intermediate school certificate and are eligible for general secondary education. Vocational and technical secondary education are also options at secondary level.

1.1.4.3 Secondary Education

In the first year of secondary school (grade 10), students share a common curriculum. At the end of the year, those obtaining a Grade Point Average (GPA) of 60% and above in all subjects may choose between the literary and scientific study programs. However, those obtaining a GPA below 60% must opt for the literary programme. The literary programme includes courses

such as Arabic Language, Islamic Studies, geography, history, and English Language. The path chosen at this stage determines the emphasis in their curriculum and restricts their undergraduate specialization (Rugh 2002). Students follow the programme for the final two years, culminating in the high school diploma (known as *Tawjihiyah* in Arabic) on successful completion of grade 12 final examinations. The examination for the high school diploma is unified and held nationwide simultaneously in schools (KASP, 2015). Alternatively, students may pursue a technical education on completion of the Intermediate School Certificate. Courses in the industrial, commercial, and agricultural schools lead to the Secondary School Diploma in the specified disciplines. Students may also study two-year vocational courses, leading to the Certificate of Technical Assistant or three-year courses leading to the Health Institute Diploma or the Certificate of Technical Nursing.

1.1.4.4 Higher Education

In Saudi Arabia, undergraduate acceptance is based on the high school diploma, grade point average (GPA), and national assessment tests, such as the Standard Achievement Admission Test (SAAT), based on science and mathematics, and the General Aptitude Test (GAT). These are mandatory for all high school students applying to pursue higher education in Saudi Arabia (MoHE, 2013), where they enter a Foundation year; Scientific Track (for graduates with scientific certificates), or the Administrative or literary track (for graduates with scientific certificates or non-scientific certificates). Currently, there are twenty-six government universities (MoE, 2017). Education is free for all Saudi Arabian students in public higher education, and students also receive a stipend to help them pay for living costs during their studies (Onsman, 2011; Elyas and Picard, 2013). The Saudi education system is focused on closing the skills gap and training students for the job market by working closely with the private sector to ensure higher education outcomes are in line with the requirements of the job market (MoFA, 2017). Skills mismatch is a problem that is being addressed by universities and some companies who are co-operating to provide student internships. Additionally, high school students above the age of 17 may engage in Summer work programs (HRDF, 2017). However, participation in these initiatives is not mandatory or implemented through collaboration with schools. Thus, more students could benefit from the services of the Human Development Resources Fund if it formed an alliance with the Ministry of Education.

The establishment of KAUST in 2009 gave the country a science and technology oriented, research-focused, university to rival the world's best. This was part of the grander plan to diversify the economy away from natural resources, transforming it into a knowledge-based economy along with several other developing countries (Corbyn, 2009; Gallarotti, 2013;

Nurunnabi, 2017; Payne, 2017). One such diversification is investment in education (Salem, 2014). In a knowledge economy, education is largely geared toward generating innovation, inventions, new products, and new modes of managing economic activity (OECD, 1996; Huyer and Hafkin, 2012; Salem, 2014). Salem (2014) argues that an educated and skilled population is needed to create, share, and use knowledge. In Saudi Arabia, this is manifested through numerous policy reforms and initiatives, thus recognising the value of human capital and the link between education outputs and socioeconomic priorities (Taibah and Jamjoom, 2013).

1.2 Women's Rights

Saudi Arabia witnessed drastic changes to its society in the 1970s, as, with the oil wealth came changes in lifestyles. Saudi Arabian women are often depicted in literature by stereotypical images, either exotic and erotic or victims of oppression, repressed subjects as mentioned by Jones (2017). However, Al Rasheed (2013) suggests that some of these stereotypical views were fuelled by a few educated Saudi women who through writing literary texts highlighted their subordination and marginalization. These Saudi women may have been exposed to and influenced by Western socialist feminist thinking on gender equality but inadvertently contributed to the negative images of the status of Saudi Arabian women. Furthermore, Hamden (2005), notes how the influx of American oil workers affected Saudi women, seeing American women driving cars and shopping while unveiled. According to Doumato (2000), this display of freedom led to Saudi women asking for the same rights.

In 1978, Saudi media published articles written by both genders about Saudi women's rights to participate in public life (Doumato, 2000), raising concerns amongst conservatives about the potential effect on social and religious traditions (Huyette, 1985), namely, increasing women's freedom and mobility through education and work (Arebi, 1994). Religion is central to life in Saudi Arabia, the birthplace of Islam. The abundance of *Masjids*[1] or mosques and prayer rooms in most venues, including malls, make it easy for men and women to observe the five daily prayers. However, following the Iranian revolution in January 1979 (Profanter, 2014), and the seizure of the of the holy mosque in Makkah in November of the same year (Hamdan, 2005), strict enforcement of religious rules, attributed to the *Wahhabi*[2] movement

[1] Masjid is the name of the Islamic place of congregational prayer
[2] A religious reform movement associated with the teachings of Muhammad ibn Abd al-Wahab (1703-1792).

(Commins, 2006), led to many restrictions enforced by the introduction of religious police which affected all Saudi Arabian citizens (Spencer, 2016).

Religious police, known as *Mutaween,* enforce restrictions including gender segregation, closure of business to allow observance of daily prayers, and strict dress codes (Al-Sharif, 2014). Cinemas were closed (Spencer, 2016; Almaeena, 2018), and the presence of Saudi women in the public sphere decreased. Except for a few ladies-only stores, all shopkeepers in the vast number of malls and markets were male, but feminization of the sales staff in shops selling cosmetics and ladieswear was enforced after the King's decree in June 2011 (Zoepf, 2010). Actions of the *Mutaween* led to several deaths (Hamdan, 2005) and a public outcry after footage of beatings went viral on social media (Cummins and Martin, 2015). Consequently, the *Mutaween* were stripped of their powers to arrest in 2016 and are now less visible and influential than in the past (Baeshen, 2017). The maltreatment of women by the *Mutaween* was against the teachings of Islam (Hamdan, 2005) which do not prevent women from joining public life (AlMunajjed, 1997). However, culturally, from an early age, Saudi girls are taught that their role is to be a wife and mother, taking responsibility of the home (Hamdan, 2012b).

Islam emphasises diverse and complementary roles for men and women, declaring that a man is responsible for economically supporting his family whilst placing a high value on a woman's role as a mother (Hussain, 1987), The Saudi family, like in many Islamic countries, is typically patriarchal (Alsubaie and Jones, 2017), where the father is the head of the household and breadwinner for the family. In Saudi Arabia, the extended family structure values mutual support above individualism and parents are involved in decision making. The importance of maintaining the family was evident when Saudi women refused to move to the compounds built by oil companies to accommodate the workers. The houses were designed for accommodating nuclear families and this would have disrupted the family structure (Jones, 2017). Such is the cohesiveness of family in Saudi Arabia that extended families often live together and elder family members are respected and taken care of. Consequently, old people's care homes are not found in the country (Khoja, 2016). Beyond the family unit, social interaction between unrelated men and women is not commonly accepted. Thus, men and women operate in their own gendered structures (Le Renard, 2008). As such, socialisation in the public sphere is categorised by family or gender (Madini and de Nooy, 2016)

Le Renard (2014) argues that the state also advocates the concept of reform to empower women in women-only spaces, jobs, and professions, but the reform is limited to specific areas of women's lives while keeping structures of domination and exclusion. Deeply entrenched

gender segregation gives women a professional advantage, as there is no competition with male counterparts for jobs in women-only spaces. Additionally, within these spaces, women develop gender solidarities and aspire to rewarding careers and professional activities (Le Renard, 2008; 2014). These solidarities tend to benefit individuals and have limited effect on society, as they rarely lead to the formation of pressure groups, since such forms of protests carry many risks (Zoepf, 2010). However, technology, in the form of social media, is helping Saudis to share their views with thousands of people (Cummins and Martin, 2015). Al-Lily (2011) points out that the initial adoption of the internet into Saudi society was delayed, as it posed challenges that could destabilise the culture. Indeed, despite governmental efforts to enforce internet censorship and the *Mutaween* to ban the use of smartphones (Cummins and Martin, 2015), the internet has had a dramatic effect on the socio-cultural pattern of higher education. Internet based applications, for example, e-learning and e-commerce enable women to remain at home and participate in employment (Al Lily, 2011). Furthermore, publicly available on-line mixed-gender forums have broken down barriers between genders whilst enabling identities to remain anonymous. Saudi women have thus gained unprecedented independent access to the outside world (Guta and Karolak, 2015). The introduction of the internet into Saudi Arabia in 1999 has enabled Saudi citizens both men and women to gain new perspectives, identify with other people's experiences beyond Saudi Arabia and voice theirs. One such example was the use of social media by Saudi citizens to expose the unacceptable behaviour of the *Mutaween* (Al-Sharif, 2014), which resulted in the removal of their power to arrest citizens.

Bradley (2015:195) argues that "women are finding in Islam an ally in their struggle for greater freedom." Unlike Islam, traditions are not sacred, suggesting that Saudi women negotiate their terms by adhering to religion and paring away what has developed as tradition over centuries of desert life and thus succeeding in contributing to transforming their lives. In addition, Saudi Arabian women are steadily gaining political power. In recent years, several laws and decrees have resulted in empowering Saudi Arabian women, reaching from the highest consultative levels, the Shoura Council, to the polls on the local level (MoFA, 2017). The Shoura Council was established in 1992 with 60 members, but has since been expanded to 150 members, each serving 4-year terms. It was in 2011 that the late King Abdullah bin Abdelaziz announced that Saudi women would be appointed to the Council. In December 2013, a royal order was issued appointing 30 women to the Shoura Council, signalling progress on women's political empowerment and bringing with them new perspectives and expertise to help push their country forward. Two years later, in December 2015, Saudi women voted in elections for the first time (Blanchard, 2017). Women won 21 seats in municipal council elections across the

country in December 2015. Over 130,000 women registered to vote and 900 ran as candidates, demonstrating their enthusiasm and commitment to participating in transforming their country (MoFA, 2017). As part of the larger-scale political restructuring in December 2016, new appointments to the Shoura Council included 29 women, with the majority holding doctorate degrees across a range of fields.

Changes are rapidly taking place to modernize Saudi Arabia. Increasing employment opportunities, investment in the cultural and entertainment sector, reopening of cinemas, and women attending football games in public stadiums, are amongst the changes (Spencer, 2016). Women are becoming more visible in the public sphere; in 2012, female Saudi athletes competed internationally in the London Olympics for the first time. The most significant triumph for women was the royal decree to lift the ban on women driving in June 2018 (Salavatov, 2017). However, the impact on their studies and employment outside of local regions cannot be assumed as additional societal concerns, especially as safety renders the issue of geographic mobility complex (Rutledge, 2017). Blanchard (2017) argues that these initiatives in favour of women have been controversial within Saudi Arabia, but to outsiders they are signs that political and social reforms involving gender issues are possible (Alyami, 2016), thus clearing doubts that such reforms which facilitate the empowerment of Saudi women would ever take place (Corbyn, 2009).

1.3 Theoretical underpinnings

Social systems (societies) consist of structurally related groups. Saudi Arabia has a highly stratified, hierarchical social system which is gender segregated in the public sphere. Most western literature describes the society as patriarchal. Walby (1990) holds firmly to the belief that patriarchal structures always restrict women and maintain male domination, but also acknowledges that due to certain factors such as class and race, women experience these structures in different ways. In the current study, gender is a structure of social significance (Risman, 2004) within Saudi Arabian society. Saudi women have progressed in education, politics, and business despite the inequalities by which they are often identified. Walby (1990) argues that patriarchy can change form, as the result of the agentic actions by either gender; for example, releasing women from domestic chores, but then exploiting them in the labour market. Furthermore, changes in structures may lead to the discontinuities in tradition, culture, social organization, and material standards (Bendix, 2017). Bourdieu (1977) maintains that social disposition engenders aspirations and practices, as essentially familiar practices are repeated rather than taking the risk of embarking on new experiences that one may not expect to be successful. In this way, the social structure is reproduced. It should be recognised that

in relation to gender, the opportunity to voice ones' opinion in certain structures might be difficult, particularly if the restrictions are deeply embedded in society (McNay, 1999). The forum for public opinion was restricted in Saudi Arabia but new modes of expression have enabled a globalised and digitised culture and exposure to new ways of thinking (Al Alhareth *et al.*, 2013), through international travel, the conventional media, the internet, and social media (Payne, 2017).

Saudi women's lives are shaped by familial support for their education (Al-Khudair and Pritchett, 2017). This is also evident in research involving Muslim parents in the UK (Crozier and Davies, 2007). One striking difference is that parental involvement in the public sphere in Saudi Arabia falls into gendered categories, as only mothers or female family members can be directly involved with a girl's school, though fathers and male members of the extended family can be involved in the private sphere. Consequently, evidence suggests that shifts in the opportunities within individual women's lives do not necessarily translate into shifts in underlying structures of constraint (Kabeer, 2008); women's agency is a key factor in achieving their aims. Agency has been the subject of numerous definitions, including, actively changing the course of events by causal intervention (Giddens, 1979) acting on socially determined practice (Bourdieu, 1984), the capability of people to do things that they value (Sen, 2005), and the ability and choice to make use of capabilities (Loot and Walker, 2015).

According to Giddens (1986), structures have no existence apart from the practices that constitute them, and these practices are reproduced by the repeated enactments of structures, thus endorsing Bourdieu's (1984) viewpoint. Nevertheless, Bourdieu and Giddens disagree on how the agent acquires the knowledge that is used in reproducing structures; unconsciously (Bourdieu) or intentionally (Giddens). Therefore, Giddens's agents are active, not passive and structures both enable and constrain human agency (Giddens, 1979; Archer, 1995). Furthermore, Sewell Jr (1992) suggests that knowledgeable agents can use their structurally formed abilities in creative or innovative ways, and their collective actions may have the consequence of transforming the very structures that gave them the capacity to act. Giddens's Structuration theory aims to explain social practices across space and time by viewing agency (action) and social structure as linked by their interdependency (Giddens, 1979). However, any attempt to argue that duality of structure improves our ability to understand social transformations challenges Bourdieu's view that duality of structure reproduces the same structure and rarely leads to transformation (Bourdieu, 1977). In societies with traditional structures, like Saudi Arabia, work-life balance must be maintained by women (Grünenfelder, 2013), in order to counteract negative impacts on the family and

work performance (Sembawa *et al.*, 2018). In such societies, working women employ a range of strategies (agency) to accomplish their responsibilities at home and at work (Naz *et al.*, 2017). Consequently, structure and agency affect each other reciprocally (McAnulla, 2002).

Giddens's structuration theory was chosen as the most suitable framework to guide the analysis of data collected in this study. The Saudi Arabian girls and women in this research navigate multiple structures, as they strive to achieve their educational and career aspirations with respect to STEM fields. In Saudi Arabia, a country that is overtly patriarchal, the interactive relationship between structure and agency enables girls and women to have patterns of social practices that are maintained over time without directly confronting or resisting patriarchal power. However, to present the voice of these participants, access to a women-only sphere is essential. Bradley (2015) described Saudi Arabia as follows: "The Kingdom of Saudi Arabia, so extraordinarily introverted and completely closed to outsiders, is perhaps the world's last great, forbidden country" (p.12). This is to be expected from a man who would had been forbidden access to the female only spheres within the country, yet his comment shows the lack of understanding of the social system and how women conduct their lives within their unrestricted gendered environments, which can be accessible to other women for critical examination.

1.4 Rationale for the Study

In the light of the above, this study gives an insight into the agency of Saudi Arabian girls and women in negotiating the patriarchal constraints embedded in Saudi society as they endeavour to fulfil both their cultural roles and STEM career aspirations. This is the first study of its kind that makes an original contribution to knowledge in the field of STEM education and careers, by presenting a view of Saudi Arabian women at a pivotal time in their lives, when the country is undergoing far-reaching reforms. It offers a fresh perspective that highlights Saudi women's empowered agency rather than their perceived oppression. It also provides illuminating insights into how students navigate the education system and emphasizes the current necessity for embedding career guidance policies in education in schools. The participants in this study were all from one university, therefore it is not possible to generalize the findings to all Saudi Arabian girls and women; however, it does offer a base for future studies.

I am intrigued by the conflict between western portrayal of Saudi Arabia and the reality of the lived experiences of Saudi women. This research was borne out of a desire to present the reality of Saudi Arabian women in the context of STEM education and careers from the

perspectives of those who have participated in this study to determine what has driven or impeded progress for women and girls in their patriarchal society. It was certainly advantageous as a female Muslim, STEM graduate, and Westerner, to have worked and lived in both the UK and Saudi Arabia. In Saudi Arabia, I worked in the private secondary educational sector for many years, but I have chosen to study girls and women in a public-sector university. Public educational institutions have massive enrolment of female students, therefore, the impact that findings may have on future decision-making policies would be most beneficial for this sector.

A thorough review of the literature on STEM education and careers revealed a considerable amount of research carried out in western settings. Literature discussed the aspirations of students in secular, educational settings and methods to increase the uptake of STEM subjects by groups who are underrepresented. Much research has focused on elucidating the shortage of women in STEM fields by addressing the effect of gender stereotypes related to STEM subjects and occupations. Furthermore, the literature also emphasized the underrepresentation of minority groups in STEM fields, but largely dealt with groups - for example, by race or gender - and did not consider religious affiliation. The literature search identified a gap regarding research about Muslim girls and women in STEM related education and careers in the Middle East, and more specifically in Saudi Arabia. It was therefore considered important to investigate the situation and identify the representation of girls and women in STEM education and careers rather than assume that there is an underrepresentation, as identified in the West. As gender is essentially a structure in Saudi Arabia, a study of both genders would have given an insight into the similarities and difference they each face in this context. However, the gender segregated Saudi society prevents female access to male universities.

This research addresses the following research questions:

1. Why are STEM-related education and careers important?

    a) What factors influence Saudi Arabian girls' decisions to study STEM subjects?

    b) What makes STEM subjects an appealing choice in Saudi Arabian Schools?

2. What kinds of STEM-related careers can be available to Saudi girls?

    a) What factors influence girls to follow careers in STEM and why?

b) What is the importance of role models, voluntary work and work placements to motivate girls to enter careers in STEM and why?

1.5 Thesis Organisation

This thesis is divided into six chapters: Chapter one presents a general introduction and background to the research study: Gender equality and how it affects STEM education and careers. It provides an overview of Saudi Arabia, the context of this study, regarding the political development of Saudi Arabia, the 2030 vision, the education system, and the impact of recent reforms on the empowerment of Saudi women.

Chapter two presents a critical review of the literature related to this study, examining notions of patriarchy and gender equality from Western and Islamic perspectives. It then concentrates on previous research related to STEM education and STEM careers, particularly students' aspirations and how they are formulated in western secular contexts, along with the possible reasons for the underrepresentation of women in STEM fields.

Chapter three presents a detailed discussion of the research methodology used in this study and offers a justification for the chosen research design.

Chapter four presents the findings and an analysis of the data related to the first research question, collected through questionnaires administered to participants and interviews conducted with a smaller sample of participants.

Chapter five presents the findings and an analysis of the data related to the second research question collected through questionnaires administered to participants and interviews conducted with a smaller sample of participants.

Chapter six, the conclusion, includes an interpretations of the findings, recommendations, limitations, and implications for future studies. It also provides a suggested strategy for the introduction of career education into the Saudi Arabian education system, one that will affect society, in general, and help to prepare citizens for the future.

Chapter Two
Review of Literature

2.1 Introduction

2.1.1 Structuration Theory

As mentioned in the previous chapter, Structuration Theory (ST) is the theoretical framework chosen to guide the data analysis in this study. Giddens' Structuration Theory (Giddens, 1984) is one of the sociological theories most widely applied to organizational research in diverse contexts. In the enduring structure-agency debate, ST introduced an alternative dimension on how structure and agency are perceived in social science (McAnulla, 2002). Giddens proposed that social practices arise from both structure and agency, phenomena that are dependent on and presuppose each other (Giddens, 1979). In other words, humans (agents) draw on social structures in their actions and those actions consequently produce or reproduce structures (Giddens, 1984). However, the relationship between agents, structures, and external pressures is not defined. For Giddens, agency is the actions of knowledgeable agents who have reasons for their actions (Giddens, 1979; Archer, 1995), whilst Bourdieu considers agency to be "largely opportunistic" (Whittington, 2015). Bourdieu argues that habitus and social disposition facilitate social reproduction and that the conscious intentions of individual actors are not a part of the social process (Bourdieu, 1977). However, Giddens rejects the idea of causal powers of structure and agency (Akram, 2013).

Giddens has been criticised for the highly abstractive nature of ST, and because ST presents concepts as simultaneous reciprocity, making it difficult to analyse how actions reproduce or modify structures over time (McAnulla, 2002; Jarzabkowski, 2008). Mouzelis and Archer are amongst the critics of the duality of structure and agency (Parker, 2000). Archer contends that structure predates agency, as humans are born into social structures (Archer, 1995) whilst Mouzelis argues that dualism and duality are both valid and depend on how each view aids the understanding of social structures (Mouzelis, 1989).

According to Giddens (1984), agents draw on their prior knowledge of structural and cultural practices or norms through reflexivity when making decisions. However, Valdez (2008) argues that a partial understanding of the structure can limit the agents' ability to exercise an effective course of action. For example, Mexican immigrant students' limited knowledge of the structure, and the routinized practices associated with applying for higher education (Giddens, 1984),

affected their ability to adequately educate their parents about college-going practices and key issues such as financial aid, unlike non-immigrant students (Valadez, 2008). Giddens used the term modalities to explain the interactions that relate to agents' knowledge and capacities to structural features of social systems. The modalities, legitimation, domination, and signification are essentially a set of rules and resources that mediate social action (Giddens, 1984).

A key concept in ST is the power of human agency for negotiating the rules governing life, which introduces the possibility for agents to transform existing structures. Giddens views power as relational, where subordinates can influence the activities of their superiors (Giddens, 1984); whilst this is possible, often it is the superiors, who by virtue of their positions are powerful, that constrain the actions of subordinates (Schimpf *et al*., 2013). Power in social contexts is complex. With respect to gender, for example, the agency of women, and their ability to follow one system of practices and to refuse another (Whittington, 2015) or to transform them, may be overestimated. This is pertinent where restrictions placed on women are deeply embedded in society (McNay, 1999), as in patriarchal societies where their agency may be regulated. In such situations, maintaining a routine pattern of behaviour avoids the potential chaos that change can bring, which Giddens described as ontological security (Giddens, 1991).

ST provides an ontological framework for social interaction that reflects the interplay of structure and agency (Giddens, 1984). Giddens leaves it to the researcher to interpret ST according to the subject of the research, which has led to the creation of adapted versions of ST. For instance, Stones (2005:7) considers ST to be too "free floating" and developed the Strong Structuration Theory (Stones, 2005), which explains conceptual and methodological links between abstract and actual social processes. Strong Structuration Theory introduces the quadripartite cycle, which explicates the elements of the duality of structure (Stones, 2005). In addition, Adaptive Structuration Theory was formulated as a means of focusing on the dynamics of group decision-making in information technology (Poole and De Sanctis, 1990).

Nevertheless, the application of ST in a wide range of empirical research suggests that researchers have succeeded in employing ST as an analytical device or as Giddens' himself put it, 'a sensitising device' (Giddens, 1984). For example, ST has been extensively used in the analysis of information systems research, (Jones and Karsten, 2008; Bhowmick, 2016) although Giddens did not mention information systems in ST. It offers a useful perspective to the analysis of management and organizational practices, (Whittington, 2015; Canary and

Tarin, 2017), accounting systems (Macintosh and Scapens, 1990), and educational research (Valadez, 2008; Russell *et al*., 2011; Singh and Hardaker, 2017).

ST provides a means of explicating how human agency creates, sustains, and modifies structures which are regulated by socio-cultural, religious and political norms, and as a lens for the analysis of gender as a social structure. Risman (2004) argues that generic structural theories applied to gender are too simplistic in presuming that, if both genders have identical structural conditions and role expectations, empirically observable gender differences would disappear (Risman, 2004). However, a structural perspective on gender is apt where gender-segregation is deeply entrenched in a social system as found in Saudi Arabia. Thus, ST is a useful guide for analysing how Saudi Arabian girls form decisions about pursuing STEM education and careers by understanding the duality between decision-making processes and the social forces that influence or constrain their choices.

2.2 Gender Equality

One of the major concerns of the Millennium Development Goals (MDGs) (United Nations, 2000) was specifically to understand gender inequities and to promote the empowerment of women, globally. Kabeer (2005) argues that gender inequalities are multidimensional and cannot be reduced to a universal set of priorities. In fact, gender equality prescribes equal rights for men and women, yet, research largely concentrates on the inequalities faced by women whilst ignoring those faced by men (Chamie, 2014a; 2014b). One reason for this is that men tend to exert tremendous power over many aspects of women's lives such as socio-economic progress in both the public and private spheres (Farré, 2013). In 2006, the Global Gender Gap Index (GGGI) was developed to measure the relative gaps between men and women across four key areas: health, education, economy, and politics (World Economic Forum, 2015). However, both the MDGs and the GGGI committees seemingly overlooked or underestimated the effects and variation of constraints presented by social relationships and cultural norms.

Cultural norms have been shown to prevent the mobility of women where transportation systems are poor, or women were previously prevented from driving (Salavatov, 2017). Another challenge is achieving access to education for women globally. In addition to educational provisions, women require time to attend classes whilst fulfilling duties in their homes. Consequently, gender equality has yet to be fully achieved by any of the 145 participating countries. However, noteworthy progress has been made in health and educational attainment, with the global gender gaps closing by 96% and 95%, respectively,

but much less progress has been reported in economic and political fields (World Economic Forum, 2015). This suggests that when gender equality is represented as gender parity, it may not be a priority in all four key areas, particularly where cultural norms are threatened and may result in policies that are ineffective (The Lancet Global Health, 2018).

International organisations emphasize the importance of education in accomplishing gender equality, as stated in the Human Development Report:

> One of the most powerful instruments for this purpose [gender equality] is education, which boosts people's self-confidence and enables them to find better jobs, engage in public debate and make demands on government for healthcare, social security and other entitlements (Malik, 2013:5).

Al Sadi and Basit (2017) argue that gender equality goes beyond equality in access to education. As the Gender Gap Report 2010 (Hausmann *et al.*, 2010) concluded that human talent was crucial for global competitiveness, gender equality policies must address existing stereotypical educational practices (Al Sadi and Basit, 2017) when considering how men and women are educated. The overarching assumption that gender equality will be achieved through educational attainment and increasing women's participation in the workforce and politics was challenged by Kabeer, who suggests that these strategies should be viewed as instruments towards achieving gender equality and women's empowerment rather than a measure of it (Kabeer, 2005).

Syed and Van Buren (2014) contend that an adequate definition of what gender equality means in practical terms has yet to be determined; consequently, gender equality is often presented as gender parity (D'Orville, 2010), as noted above. It is evident that achieving gender equality is problematic due to cultural and religious variations across countries and expectations of what gender equality should look like. According to Abu-Lughod (2013), models of gender equality used by Western feminists when discussing Arab women are often unfitting, as they ignore or devalue local cultures. These models focus on human rights (Al Sadi and Basit, 2017) and omit religion which is fundamental in the lives of Muslim women (Badran, 2013), who understand that Islam does not propagate gender inequality (Davids, 2015). The stance of some countries on the gender parity concept of gender equality highlights the dichotomy of simultaneously adhering to global policies and socio-religious norms. This is clearly illustrated in the case of Saudi Arabia.

Saudi Arabia ratified the Convention of Elimination of All Forms of Discrimination Against Women (CEDAW), (OHCHR, 1979) with reservations, stating that the Kingdom was under no obligation to observe any terms of the treaty that contradict Islamic law (Kelly and Breslin,

2010; Buang and Suryandari, 2017). The USA has yet to ratify CEDAW because of opposition from Christian religious groups (Lowen, 2017). While Saudi Arabia committed to achieving the Millennium Development Goals (MDGs) (United Nations, 2008), with respect to the third goal (gender equality and women's empowerment), its focus was confined to increasing women's participation in the labour market (Al-Rushaid, 2010). This continues with the introduction of the Sustainable Development Goals (SDGs) (United Nations, 2017a). According to the reforms outlined in the 2030 Vision, 30% participation of Saudi women in the workforce is one goal (Al-Saud., 2016). There has been significant interest in western research related to Muslim women and gender issues since the events in the 1970s (see chapter 1.2) and the terrorist attacks of September 11. Western observers of the predicament of Muslim women have portrayed Islam as uniquely patriarchal and incompatible with women's equality (Offenhauer and Buchalter, 2005). The next section gives a brief historical insight into patriarchy and the portrayal of women in different societies.

2.2.1 Women in Patriarchy

Defining patriarchy has been problematic, particularly because definitions fail to adequately deal with historical and cultural variations (Walby, 1990). Walby (1990) defines patriarchy as a system of social structures and practices in which men dominate, oppress and exploit women. Although Walby acknowledges that her model may not be applicable in non-western settings, she also overlooked the multicultural and multi-religious nature of western settings even at that time. Whilst patriarchy has been associated with some religions, research suggests that the Patriarchal Belt[3] predates the existence of religions found in the region and cuts across cultural traditions outside of the patriarchal belt (Littrell and Bertsch, 2013). The three main religions in the World are the Abrahamic faiths - Judaism, Christianity and Islam, which share a common monotheistic belief in one God. Offenhauer and Buchalter (2005) contend that the sacred books of these religions have been interpreted to support existing patriarchal social relations rather than patriarchy being a religious concept - a view supported by Littrell and Bertsch (2013), indicating that subjugation of women was intentionally and socially constructed.

Historically, women were globally thought to be weak based on male superiority, which was a sociological and not a theological belief (Engineer 2008). This view is evident in both secular and religious cultures e.g. social attitudes regarding the relative value of men and women in

[3] The Patriarchal Belt is an area that includes North Africa, the Muslim Middle East, some sub-cultures in Turkey, Central and South Asia; all regions with similar gender relations and perceptions of women

Europe led early modern parents to favour the birth of sons over daughters. Jewish women prayed for sons, German midwives were rewarded for delivering boys, and English women's letters sometimes apologized for the birth of daughters (Wiesner 2000). The hierarchical characteristic of patriarchy demanded that the number of male members in families exceed females in order to fulfil future responsibilities as the provider and head of the family.

Interestingly, Stone (1977) argues that in England the patriarchal family structure began to break down in the seventeenth century, giving way to an egalitarian alliance between spouses (Stone, 1977), yet Bradley maintains that the patriarchal ideology is still evident in all societies at times (Bradley, 1989). This is consistent with the ongoing campaigns for gender equality by feminists and global entities alike. Although women claimed they were exploited through unpaid work in the home (Siegel, 1994), they willingly joined the labour force during the industrial revolution where they were cheaper to hire than men (Bradley, 1989), thus liberation from housework shifted to exploitation in the workforce. Additionally, there are cases where political situations have demanded that women participate in the workforce such as in the UK and France after World War I (Grayzel, 2014) and the Iran-Iraq war where the shortage of men led to the recruitment of Iranian women (Moghadam, 2003).

The dichotomy between economic (additional income) and traditional (patriarchal, male breadwinner) motives for women to work (Walby, 1990) has caused conflicts in the family structure. Moghadam (2012) contends that socio-economic development can either be detrimental or beneficial to women in patriarchal societies. In contrast, Islam emphasises diverse and complementary roles for men and women, declaring that a man is responsible for economically supporting his family, whilst placing a high value on a woman's role as a mother, thus emphasising that both genders are equal but have different roles. The Holy Quran states:

> Men are in charge of women by [right of] what Allah has given one over the other and what they spend [for maintenance] from their wealth. So, righteous women are devoutly obedient, guarding in [the husband's] absence what Allah would have them guard. (Quran 4:34)

Patriarchy is mostly associated with negative connotations such as male dominance and female subordination (Walby, 1990), which would confirm that patriarchy violates the human rights of women. However, patriarchy outdates Islam and should not be confused with the Islamic responsibilities of the *Mahram*[4] (male guardianship), as mentioned in Quran 4:34 above. The role of the *Mahram* conflicts with and negates the characteristics of patriarchy,

[4] Mahram is a male guardian whom a girl cannot marry, her grandfather, father, brother, and uncle.

therefore the terms should not be used interchangeably.

Interestingly, provisions made for the safety and security of women in Islam are dismissed by feminists who strive for individuality and freedom (Abu-Lughod, 2013). As for the Muslim women, their perspectives on having a Mahram vary, with some indicating the benefits of being pampered (Farmer, 1971) and being comfortable with their situation (Zoepf, 2010), while others seek liberal rights (Ahmed, 2014).

2.3 Muslim Women in Western Literature

Cultures conceptualize socially acceptable roles for women differently (Kabeer, 2008; Syed and Van Buren, 2014). Offenhauer and Buchalter (2005) argue that stereotypes of Muslim women have long prevailed in the West, distorting the enormous interregional, intraregional, and class variations in their circumstances and status (Offenhauer and Buchalter, 2005). Alsanea crossed socio-cultural boundaries in Saudi Arabia when she penned the novel, *Banat Al Riyadh* (Girls of Riyadh), in 2008. As a Saudi Muslim girl, she gave a rare glimpse into the private lives of her friends - a group of upper-class girls. Interestingly, she wrote in the foreword of her book:

> The Western world perceives us romantically, as the land of the Arabian Nights and the land where bearded sheikhs sit within their tents, or politically, as the land that gave birth ……. to terrorists, the land where women are dressed from head to toe in black and where every house has its own oil well in the back yard! (Alsanea, 2008: Authors note)

Abu-Lughod (2013) argues that popular literary representations, memoirs about Muslim women from travel, and missionary literature are commercial products that readers receive in a specific political context. For example, the classic novel, *Arabian Nights,* written in the 19th century, was widely accepted as an accurate picture of Arabia, although it depicts Arab women as one homogenous group. Until the discovery of oil in the 1930s, there was little interaction between Saudi Arabian people and Westerners, aside from the Western Muslims visiting Saudi Arabia for pilgrimage. Foreign workers arriving in Saudi Arabia had preconceived views of Arabian women based on earlier writings, but the unfamiliar system of gender roles they observed, was interpreted as oppression and subjugation (Jones, 2017), rather than just difference. Farmer (1971) recollects how she found Saudi Arabian women redefining a role that she understood was often restricted to fetching, carrying, and breeding during her visit to Saudi Arabia. She was clearly surprised to find Arab women who were smart, sophisticated, talented, intelligent, and athletic. She mentioned interviewing a perfect example of the Arab

girl few westerners ever hear about, those depicted as lovely, literate, coolly independent, and impressively educated.

Narayana and Ahamad (2016) argue that the media can be an agent of change or an agent of oppression. The visual presence of veiled women signifies the Muslim women's subordinate status in the Arab world, implying disgrace or shame (Yamani and Allen, 1996). Farmer (1971:1) envisaged that Muslim women unveiling would indicate some form of liberation:

> "When the last vesting's of the veil have disappeared, those who regret its passing will, I think, be few. Symbolizing as it does, the shadow of a time when women from the lowest to the highest, the most educated to the illiterate, were begrudged not only freedom of marriage, of association, of movement but even daylight."

The fact that she mentioned 'those who regret its passing' implied a forced unveiling, which amounts to transferring, not eliminating, oppression. Syed and Van Buren (2014) argue that Muslim women have been portrayed as oppressed, subservient, and passive by the media, but Al-Rasheed (2013) claims that a handful of Saudi Arabian women educated in neighbouring countries were drawn into teaching and the production of literary texts. They used these literary texts as a means of highlighting their cause but inadvertently added to the already existing negative stereotypes. Furthermore, the Gulf wars and the tragedy of 9/11 (Ahmed, 2014) have drawn further attention to the region and the issue of Saudi women's rights (Alharbi, 2015). Much of the media attention has focused on Saudi Arabian women, because of its strict, gender segregated infrastructure, which differs from many other Islamic countries. Thus, although Western literature was previously limited in its portrayal of Muslim women, this has changed slowly. Exposure to Muslim women through travel, education, media, and more recently the internet and social media development, have helped to counter negative stereotypes and generate positive images of Muslim women.

In recent years, highly educated Saudi women have utilized the media and particularly social media to highlight their advancements and their causes, but their contributions to society (Payne, 2017) are frequently overshadowed by the news of their hardships (Narayana and Ahamad, 2016). Just like the veil, the ban on women driving in Saudi Arabia is a constant topic of discussion in the media (Salavatov, 2017). Since the driving ban has been lifted, media focus has shifted to the eradication of male guardianship. A growing number of Muslim women and men are articulating their views in social media campaigns (Guta and Karolak, 2015), regarding the potential limiting effect of male guardians on women's educational and employment opportunities (Al-Asfour *et al.*, 2017) and issues surrounding domestic abuse (HRW, 2016). Consequently, male guardianship is portrayed in the media as another obstacle

in the emancipation of Saudi women (Hebbelthwaithe, 2014) without full knowledge of the guardianship law and its main objectives (Alharbi, 2015).

The discourse surrounding the condition of Arab Muslim women today, necessitates a review of the society in which Islam was revealed and the condition of Arab women prior to the advent of Islam.

2.4 Arab Women in Pre-Islamic Times

The period before Islam is known as the 'Period of Ignorance' or *Jahiliya.* Details from this period are relatively scarce, but have been retrieved from Assyrian, Hebrew, Greek and Latin sources, as well as the poetry from the Age of Ignorance and proverbs. The Quran also gives detailed information related to the pre-Islamic Arabian religions of the polytheist Arabs (Utku, 2013). According to Hawting (2011), *Jahiliya* describes the lives of Arabs in the western central Arabia in the century prior to the advent of Islam. Thus, pre-Islamic literature concentrates on the region of Arabia that is seen as relevant to the understanding of Islam and not Arabia in a wider geographic sense (Hawting, 2011). Mawdudi (2013:43) describes Arabia during this era as isolated, "a territory where darkness lay heavier than elsewhere," where worshipping idols, immoral behaviour, immodesty, and adultery were all commonplace.

During this period, there was no unified government and Arabian society was based on a tribal system, social values, and rules, all rooted in tribal tradition established by the elders of the tribe. Each tribe considered itself a sovereign unit. Male elders formed the Shoura Council, an instrument of social ethics. They gathered in *Dar al-Nadwa* (places of congress in Makkah) to discuss actions regarding each situation (Zayd 2006). Shoura Council is still held now, in a reformed manner (Jordan, 2013; Baeshen, 2017).

The family structure was patriarchal and family relations were patrilineal. Uktu (2013) argues that children were treated differently according to gender. Sons were thought to strengthen the family and raise the status of the tribe (Utku, 2013) whilst daughters were buried alive for fear that an increase in female offspring would result in economic burdens (Mawdudi, 2013; Behniafar and Eftekhariyan, 2016). Interestingly, Smith (1903:294 cited in Muslim Women's League, 1995) noted that "another reason for infanticide was for tribal chiefs to avoid shame and disgrace, should their daughters be captured and become slaves of the enemy, as tribal wars were a common occurrence at that time." This suggests that the protection of women was extremely important as a sense of tribal pride, and infanticide was believed to remove the

burden of protection and the fear of humiliation. Quranic evidence points to the practice of female infanticide:

> When any of them is given the good tidings of a girl, his face is darkened, and he chokes inwardly, as he hides himself from the people because of the evil of the good tidings that have been given to him, whether he shall preserve her in humiliation, or trample her into the dust (Quran16:58–59).

During pre-Islamic times, women were treated no better than a commodity, they lived in subjugation and degradation (AlMunajjed 1997). Engineer (2008) argues that women were deprived of their inheritance. According to Behniafar and Eftekhariyan (2016), the motive was to inhibit the transmission of family wealth to another family when women remarried. Marriage was not an institution that guaranteed family life, as multiple forms of marriage including polyandry and polygamy were prevalent and women could be inherited as a possession (Engineer, 2008). A condition of marriage was that women were paid a *dowry* (Utku, 2013), but often it was retained by the father who added it to his own wealth. Additionally, women had no parental rights over their children, even if the husbands died (Engineer 2008). This mistreatment of women was widespread, but evidence suggests that women of noble status were held in high esteem (Mubarakpuri, 2008). Furthermore, Muslim Women's League (1995) claim that women in Makkah could marry and divorce at will, engage in trade and hold property, suggesting that the laws regarding inheritance may have been influenced by foreign commercial contacts.

Consequently, Quranic revelations began at a time when people had lost their knowledge of the true religion and had reverted to polytheism, (Gulen, 2001). Arab Society in *Jahiliya* was not concerned with any kind of systematic education for males or females, (Parveen 2014). As mentioned above, historical literature provides differing accounts as to the status accorded women in Arabia prior to the coming of the Prophet Mohammed (PBUH), in 500AD, and the subsequent spread of the religion of Islam. However, as one of the fundamental objectives of Islam's message was to bring about a significant improvement in the status of women, it implies that more women were subjugated than privileged during *Jahiliya*.

There are numerous works relating to women in Islam, but the literature reviewed here relates specifically to Muslim women in Saudi Arabia, as it is not the aim of this study to review Islam as a religion or Muslim women in other societies.

2.5 Muslim Arab Women and Islam

The social reforms presented by Islam were not readily accepted by the wealthy merchants of Makkah (Lacey, 2009). Mubarakpuri (2008) argues that their beliefs in idolatry where being challenged, and according to Lacey (2009) they feared losing the fortunes gained from the pilgrims. To avoid enraging the tribal leaders, the call to Islam was initially a clandestine operation (Mubarakpuri, 2008), which suggests that adoption of social reforms was slow. Nonetheless, Arab women who embraced Islam became legally entitled to inherit and bequeath property, and to hold their wealth in their own names even after marriage (Vidyasagar and Rea, 2004; Aslam, 2009). Islamic law granted women rights as a wife, a sister, a daughter, a member of the Islamic society, and as mother.

There are numerous verses in the Quran which established rights for women and children, including a complete chapter devoted to women (*Surah An-Nisa*), which erased numerous ambiguities including inheritance and which emphasized women's rights and duties (Engineer, 2008; Behniafar and Eftekhariyan, 2016). Furthermore, the Quran outlawed infanticide, stressed the woman's right to a marriage contract, and provided guidance for the protection of the widow and orphans, with a specific emphasis on the girl orphan (Davids, 2015). Addressing either husbands or guardians, women are given the right to their property: "And give the women their dowries with a good heart..." [Quran 4:4]. Thereafter, dowry was paid directly to the wife not her father or tribe (Büchler and Schlatter, 2013). The Quran gave women equal, but not identical, rights with men on personal, civil, social, and political levels. Neither the Quran nor the *Hadith* prevented women from joining in public life but warn that free mixing of the sexes can have negative consequences (AlMunajjed, 1997). Thus, the practice of seclusion of women is a comparatively recent phenomenon (Alsubaie and Jones, 2017).

Büchler and Schlatter (2013) argue that Islam established the family as the core constituent unit in society, leading to the change from a tribal culture to a family-based structure. However, considering that one of the arduous tasks of the tribal chiefs was to protect the family, especially women, Alharbi (2015) maintains that traces of the tribal system gave rise to the extended family structure. The extended family includes grandparents, aunts, uncles, cousins, and in-laws, with the grandfather being the head. Decisions for individuals were made by the head of the family after consultation with the extended family and affected women's rights the most (Alharbi, 2015). Additionally, the private religious behaviours of Muslims are also a route to decision-making. Believers often seek guidance in the form of prayers such as *Istikarah,* a special prayer where a Muslim asks God for guidance in making decisions. The outcome of

the *Istikarah* prayer supersedes family decisions based on the belief that "religion specifically guides daily life choices" (Glas *et al*., 2018:690). This closeness to God is not the free choice idealized in CEDAW, but it is very much about consent and choice (Abu-Lughod, 2013).

Runzo (2014) argues that the common notion that religion is an enemy to human rights is misguided and detrimental to the positive role that religion can have. Muslim women have economic and social rights granted to them by the Quran long before such rights were attained in the West. However, the status of women under Islamic law has been affected through customary laws, social practice (Alharbi, 2015), and discriminatory customs regarding rights and inheritance (Aslam, 2009), which are still prevalent in some countries.

2.5.1 Western Feminism

It is not clear when women's movements first began, but they can be traced back to the eighteenth-century, and the French revolution (Pugh, 1997). Later, interest spread to other countries, as documented in *A Vindication of Rights of Women* (Wollstonecraft and Pennell, 1892). While strongly critical of presumptions that women are naturally subordinate to men, Wollstonecraft's aim was not to take women out of their families, but she contended that educated, autonomous women would make better wives and mothers (Bowden and Mummery, 2014). Western feminism has gone through changes, referred to as the three waves of feminism, with a fourth emerging (Rampton, 2015). Each wave addresses different issues, from women seeking their political rights, to fighting social and cultural inequalities, in addition to demanding reproductive rights and sexual freedom. Feminism today is quite distinct from the early women's movements (Anderson, 2015), and Rampton (2015) argues that young women believe that it no longer represents just the struggles of women, but is a call for gender equality instead.

Redfern and Aune (2013) acknowledge the widespread support for the principles of equal pay, equal opportunities in education, access to employment and political representation at all levels in the West. Nonetheless, Bowden and Mummery (2014) argue that access and participation have not necessarily translated into the end of women's oppression and exploitation. Furthermore, women's visibility in popular culture does not mean they are valued, are safe from violence, or are equal to men (Redfern and Aune, 2013). In fact, Anderson (2015) contends that feminism is relevant and necessary until gender equality is achieved. Nevertheless, global disparities and continued oppression of women in less developed countries have attracted criticisms from western feminists (Bowden and Mummery, 2014), though the gender equality targets of CEDAW and similar global initiatives have yet to be

achieved by any country (OHCHR, 1979; United Nations, 2017a). As mentioned previously, the difficulty in reaching a uniform definition for gender equality, which satisfies all countries and cultural and religious nuances, is a limiting factor in its achievement (Runzo, 2014).

"Western feminists have not drawn upon Islamic texts when addressing gender inequalities in Muslim societies" (Hashim, 1999:7), but have applied their own conclusions to the situation of Muslim women. This is considered to be an intrusion by Muslim women (Yamani and Allen, 1996). Western feminists conclude that Islam is uniquely patriarchal and incompatible with women's equality (Offenhauer and Buchalter, 2005). In fact, Muslim women view the Western feminist model as defective, as it ignores the role of motherhood, has been constructed outside of religious frameworks (Davids, 2015), and has been viewed as partly responsible for the disintegration of the western family (Yamani and Allen, 1996). The interest of western media in women in Islam energized religiously committed Western Muslim feminists to engage with the topic of Islam and women's rights, causing a rise in Islamic feminism (Ahmed, 2014).

2.5.2 Islamic Feminism

Previously, because of illiteracy and the inadequate provision of education, many Muslim women were unaware of the protection afforded to them by state legislation and were unfamiliar with classical Islamic rules (Büchler and Schlatter, 2013). The term 'Islamic feminism' became popular in the 1990s, yet Moghadam (2003) debates whether Islamic feminism represents a new feminist paradigm or endorses Quranic gender equality. Davids (2015) indicates that it represented the perspective of several Muslim women who were neither Islamists nor secular feminists. Islamic feminism did not define these women, and many still reject the term. Islamic feminism clarified the distinction between these Muslim women, and the two dominant approaches for their rights: Islamists and secular feminists (Wadud, 2002). The feminisms that Muslim women have created are feminisms of their own, and religion has been integral to their construction (Badran, 2013). Wadud (2010) claims that Islamic feminism is based on the principles of Islam, but Davids (2015) argues that Wadud (2010, cited in Davids 2015:320) "neither explains how feminism in Islam is based on the principles of Islam, nor clarifies what these principles are."

From the perspective of Islamic feminists, human rights are not contradictory to Islam (Mir-Hosseini, 1999). Muslim women have economic and social rights clearly presented in the Quran, but these rights are often suppressed by male domination or left unclaimed due to inadequate education and Islamic knowledge (Büchler and Schlatter, 2013). In several Islamic societies, the rights ascribed to Muslim women deviate from the actual practices (Yamani and

Allen, 1996). The exclusion of Muslim girls and women from education and employment (Abu-Lughod, 2013) are just two examples, which have now reduced significantly. Some Islamic feminists argue that the interpretation of Islamic sources is androcentric and called for its reinterpretation (Roald, 2001). Most Muslim women want to have rights from within Islam (Parker-Jenkins *et al.*, 1997), but Roald (2001) notes that this requires cooperation with Muslim men, including their perspectives on any reinterpretations. This indicates that improved access to education and Islamic education have enhanced the Muslim women's religious agency. Through agentic socialization, women have identified discriminatory practices and have become better equipped to diverge from patriarchal practices (Glas *et al*., 2018).

2.6 Saudi Women and Saudi Society

Saudi Arabia is known to be the most conservative country in the Middle East, with rich cultural, family, and moral values that can often appear restrictive or even oppressive to the Western world (Islam, 2014; Zillman, 2017). The patriarchal traditions displayed in some countries reflect societal or cultural rather than religious mandates, but the dramatic societal changes witnessed in Saudi Arabia in the 1970s resulted in a rapid decline of the liberalization of women (Profanter, 2014). For example, Wagner mentions a 55-year-old Saudi university professor who related that he could not recall ever seeing his mother wear the *abaya* when he was young, and she drove anywhere she pleased (Wagner, 2010). All Saudi Arabian citizens were affected by these restrictions, but literature tends to focus on the women as they wear the black *Abaya* and some veil in public (Spencer, 2016) making them visually noticeable, though not identifiable.

An alternative argument is presented by Al-Rasheed (2013) who attributes the changing practices in Saudi Arabia to Islamic nationalism and oil wealth. According to Le Renard (2008) and Al-Rasheed (2013), the wealth created through the oil industry diminished the need for women to work, although historically Muslim Arab women participated in all aspects of life politically, socially, and economically (Reda and Hamdan, 2015). Subsequently, non-working women became a symbol of wealth and moral standing. Hence, an unexpected consequence of oil wealth was the ending of the careers of some ambitious Saudi women.

Al-Rasheed (2013) points out that the situation is changing. Saudi women are increasingly involved in the public sphere, because of the arbitration between society and religion, sanctioned by King Abdullah (Fatany, 2013). He championed women's emancipation by increasing access to employment and appointing women to the Shoura Council in January

2013 (Jordan, 2013). Later in 2015, women voted autonomously in the local elections for the first time, signifying that the views of both women and men were important to the development of Saudi Arabian society.

In addition to participating in the public sphere in their home country, Saudi women are getting involved in global networking through social media. The dichotomy of participating in global networking or maintaining social cohesion was a huge problem for Saudi Arabian authorities (Al Lily, 2011; Madini and de Nooy, 2016). Global networking involuntarily removed the restriction on freedom of speech in Saudi Arabia and the influx of un-Islamic ideologies. Guta and Karolak (2015) argue that the internet with its protection of individual privacy provided Saudi citizens with a social networking resource that brought new realities to their lives. In 2017, 70.49% of the Saudi population were internet users (Statista, 2017). Globally, Saudis are one of the largest adopters of social media, especially Twitter (Al-Sharif, 2014). Both Saudi women and men are contributing to the public sphere in ways that are not possible outside of the virtual world, a space where they can express their voices internationally (Guta and Karolak, 2015).

2.7 Saudi Women and Education

Studies have shown that individuals view education as a passport to a better life, an increase in earnings capacity, realising one's potential and improving social mobility, amongst others (Kumar, 2013; Assaad *et al.*, 2014; Warhurst, 2014). With respect to acceptance, the landscape of girl's education in Saudi Arabia has changed tremendously over the past 60 years. The Saudi government joined global initiatives including Education for All (EFA) (World Bank, 2014) and committed to the MDGs (Sachs, 2015), which were developed to ensure access to quality basic education and reduce poverty, globally (Benavot, 2015). According to the EFA report 2015, Saudi Arabia showed one of the fastest declines in illiteracy achieving 99% youth literacy and 97% adult literacy by 2012 (Benavot, 2015); a tremendous achievement in a country where the female literacy rate was a dismal 2% in 1970 (Younus, 2012; Al-Asfour and Khan, 2014). Rugh (2002) attributes the rapid increase in education enrolment to it being heavily subsidized by the government but questioned the quality of the education delivered. Similarly, other studies have raised questions about the quality of modern education in Saudi schools (Chapman and Miric, 2009; Bolshakova *et al.*, 2011; Alsaeed, 2012).

2.7.1 Educational Quality in Schools

Chapman and Miric (2009) compared the effectiveness of the educational systems in the Middle East and North African (MENA) region, which have similar traits. Despite higher government spending than many other nations and teacher interventions, educational achievement was lagging in Saudi Arabia, particularly in mathematics and science (NCES, 2007). Ineffective teacher preparation programs, lack of formal teaching qualifications, (Dickson and Kadbey, 2014), programs imparting the wrong knowledge, or teachers not implementing skills gained in training (Chapman and Miric, 2009) were all identified as possible causes. Dickson and Kadbey (2014) also argue that, prior to 2009, teachers used limited pedagogical strategies. Consequently, countries in the region independently embarked on educational reforms to address the problems through heavy investment in education, rapid development of education at all levels and policy borrowing from Western countries (Almazroa and Al-Shamrani, 2015).

As far as STEM subjects were concerned, in 2008, the Ministry of Education (MoE) introduced new math and science curricula; translated and localised versions of American textbooks that stress student-centred learning, problem solving and critical thinking (Dickson and Kadbey, 2014), thus intentionally, replacing the old pedagogy of rote learning and teacher centred learning (Alghamdi and Al-Salouli, 2013). Research shows that changing from structured and teacher-controlled learning spaces to 'student centred' approaches is unsettling for some students (Burke and Crozier, 2014). In the Saudi context, it is likely that the transition from rote memorization to student centred approaches would be problematic for both students and their teachers, who may lack confidence and training in implementing the new pedagogies.

In Saudi Arabia, both organisational (school) and teacher autonomy is limited, which according to Rugh (2002), reflects one of the key features of Saudi education, which is government control. The government employ a top-down approach to curriculum implementation (Alghamdi and Al-Salouli, 2013), and teachers are rarely consulted on educational matters. Evers *et al.* (2017) argue that teacher autonomy, that is, the freedom to act professionally, is critical. Furthermore, teacher participation in curriculum development and implementation is critical (Evers *et al.*, 2017) and is empowering (El-Deghaidy *et al.,* 2017). Alghamdi and Al-Salouli (2013) discuss a complex range of issues that teachers encountered in implementing the new science curricula, which they suggest may have been averted with their input in the development of those curricula. Nonetheless, teachers' narratives indicate that the curriculum advanced the students' skills development, but teachers resorted to rote memorization at times to ensure completion of the curriculum (El-Deghaidy *et al*., 2017).

2.7.2 International Assessment

Student achievement in Saudi schools is measured by regular summative assessments, which determine progression from one grade level to the next. Global educational performance testing for school age children has gained popularity, as student performance is measured using international standards e.g. Trends in Mathematics and Science Study (TIMSS). The math and science performance of students from Saudi Arabia was significantly lower than average, compared to students in the UK for both year 5 and year 9 in TIMSS 2011 (Sturman *et al.*, 2012) and suggested that the quality of education was in a state of crisis in all the participating Arab states (BouJaoude and Gholam, 2013). Additionally, TIMSS 2015 revealed a decrease in average scores for Saudi Arabian students in both mathematics and science since 2011 (Mullis *et al.*, 2016a; 2016b). Although girls in grade 4 performed better than boys in mathematics (Mullis *et al.*, 2016a), at grade 8, the difference was insignificant. Gender differences favouring girls' performance were found in grade 8 science (Mullis *et al.*, 2016b), but overall the performance of students had decreased from the previous four years. It is not clear how many Saudi students were examined for TIMSS, therefore the results may have represented a snapshot rather than the full picture. Nonetheless, the results were unsatisfactory, demanding a review of the new curricula and the type of preparation students received prior to the TIMSS tests. Clearly, evidence of how learning takes place needs to be transparent to facilitate improvement. TIMSS is advantageous in providing an international benchmark, which is important considering global competitiveness.

2.7.3. English Language

Throughout the literature reviewed, there is a common trend regarding the adoption of western ideas in Saudi Arabia, showing concerns that Saudi cultural traditions and religious norms may be threatened. Competing internationally and upholding traditions have been the aim of domestic and foreign policies (Onsman, 2011). Hence, English language became crucial for Saudi Arabia, with its large expatriate community, as a means of global communication and local communication. Furthermore, it is the medium of instruction for STEM and Medical related majors in higher educational institutions and universities in KSA. Therefore, there is a need to enhance the quality of English language skills taught in schools (Al-Asmari and Khan, 2014).

Students and teachers in Saudi Arabia have reported that English lessons are frequently taught in Arabic (Mitchell and Alfuraih, 2017). Al-Nofaie (2010) argues that using the native language is unavoidable depending on student's needs, but previous research led to much

debate about excluding it (Richards and Rodgers, 2014; Cook, 2016) as foreign language acquisition would possibly be reduced. On the other hand, when teachers used their native language in explaining grammar, learners demonstrated good progress (Al-Nofaie, 2010). As noted above, the need to improve English proficiency in Saudi Arabian schools was identified, indicating that the dependency on using the Arabic language in English lessons was hampering student's English language acquisition.

2.7.4 Teacher Training

Presently, a pre-requisite for teaching in Saudi Schools is a four-year bachelor's degree. Elementary education and Special Educational Needs degrees are taught in teachers' colleges whilst potential school science teachers are taught education theory and methods in addition to their specialization (Mansour *et al.*, 2014). However, the shortage of science teachers pressured the MoE to employ science graduates (Mansour *et al.*, 2014) without teaching skills (Mitchell and Alfuraih, 2017). To tackle the lack of training, teachers may attend workshops organised or approved by the MoE at the discretion of the school principal (TradeArabia, 2014). This raises questions about the minimum standards for teacher education, the MoE's educational policy, and the uptake of professional development by teachers in general.

Saudi Arabia's educational reforms involved the implementation of a series of projects. The Education Development Project, commonly known as Tatweer [5], works very closely with the MoE to design and implement innovative evidence-based education improvement initiatives (Elyas and Picard, 2013; Almazroa and Al-Shamrani, 2015). Tatweer initiated a series of training programs for male and female teachers: in 2011 for ICT (Alenezi, 2015) and in 2014 for science, mathematics, and English teachers. One aim was to train over 100,000 teachers in pedagogical skills and knowledge in the mathematics and science fields (Miller, 2014), whilst the English training addressed the need to improve the English language proficiency of practising Saudi Arabian teachers (Mitchell and Alfuraih, 2017) and enhance the quality of English language teaching throughout the Kingdom (TradeArabia. 2014).

Almazroa and Al-Shamrani (2015) argue that, despite these training programs, changes in practice are essential for professional development to be effective. Mitchell and Alfuraih (2017) add that the training needs of thousands of teachers have yet to be addressed. This suggests

[5] Tatweer is an Arabic expression which means self-development (Elyas and Picard, 2013)

that a more robust program is needed to ensure that all teachers receive adequate training with measures to ensure implementation. Thus, the current approach of in-service training needs to be revisited and evaluated for effectiveness.

A recent initiative by Tatweer Company for educational services (T4EDU) indicates that a comprehensive overhaul of the Saudi educational system through content development and an e-solutions system is currently underway (T4EDU, 2018). This includes STEM textbooks with supplementary resources, a National Education Portal, and online training programs for teachers. T4EDU (2018) claims to link formal and informal education through learning in accordance with STEM methodology. Teaching and learning programs, events and activities are designed and practised in alignment with the state-of-the-art standards to support and achieve the educational objectives. Although global research perspectives, on how discipline integration can be achieved have resulted in insufficient directions for STEM advancement and approaches to STEM (English, 2016). Furthermore, El-Deghaidy *et al.* (2017:6) found that Saudi teachers prepare lessons independently and school culture did not foster interaction across disciplines, as "it is not common that science and mathematics teachers sit together to identify crosscutting content or skills." This has implications for the integration of STEM approaches in schools where subjects are still taught in strictly isolated disciplines; biology, chemistry, mathematics, and physics. English (2016) argues for a balanced approached to STEM integration; teaching engineering skills need to be incorporated as in most schools, globally. It remains to be seen if the MoE will alter school culture by enforcing interdisciplinary collaboration between teachers, to effectively support STEM education.

2.7.5 Technology

The introduction of distance education through e-learning helped to curb the shortage of female instructors, enabled access to education at all levels for students living in remote areas, in dangerous areas and for others who were employed and could not attend full-time courses (Al-Shehri, 2010; Alhareth *et al.*, 2015; Quadri *et al.*, 2017). Although e-learning has notable advantages, including the removal of place, distance, and time barriers, Quadri *et al.* (2017) found that huge government investment in technology in education was not reflected in its adoption and implementation across many Saudi higher educational institutions. Improving educational technology provision is a national priority (Alothman *et al.*, 2017). Al Gamdi and Samurai (2016) argue that all higher educational institutes strive to cope with the advancing technologies, indicating the difficulty is not exclusive to Saudi Arabia. Alenezi (2015) maintains that the mandatory ICT implementation lacks policies that foster teacher collaboration, and a clear strategy for the changes. Consequently, teachers are reluctant to changes in a system

that many believe is already successful. Additionally, technical competencies, and poor infrastructure were identified as limiting factors across Saudi Arabian educational institutes (Al Gamdi and Samurai, 2016).

School and teacher level obstacles affect the effective and innovative use of technology in schools (Alothman and Robertson, 2015; Bingimlas, 2017), particularly due to lack of training on technological equipment usage (Karkoulia, 2016). According to Alenezi (2015:638):

> Political and socio-economic advantages of using ICT in Saudi school settings are not correlated with cultural concerns about outside influences that are hazardous to the segregated system of education and Islamic beliefs.

The safety and privacy of students and female teachers is preserved by the MoE by preventing students from bringing mobile communication devices including smart phones and tablets to schools (Alabdulkareem, 2015). Nonetheless, students are active internet users at home and are encouraged to access learning resources provided by the MoE online. This suggests that whilst the internet is accessible and beneficial as a learning resource, the MoE's stance on using mobile communication devices within schools is a barrier that needs careful negotiation. This limits the access of individual students to the vast range of technological applications available for STEM education during the school day.

2.7.6 Student Enrichment Programs

2.7.6.1 Gifted and Talented Programs

Alenezi (2015) stresses that the integration of modern technologies requires a new culture of teaching and learning to be rooted in Saudi Arabia. The implementation of projects such as the Mawhiba School Partnership Initiative (MSPI) is a step towards changing the culture of teaching, as discussed below. Nurturing the talents of the gifted and talented students is a means of contributing to the Kingdom's goal of creating a knowledge society (Mawhiba, 2015). MSPI is an enrichment program embedded in selected schools with entry points in grades 4, 7, and 10. Students achieving high scores in the national IQ test are offered full scholarships to attend *Mawhiba* accredited schools within Saudi Arabia. *Mawhiba* conceptualized the delivery of the enrichment program to both *Mawhiba* scholars and other academically-able students within the schools. However, as Batterjee (2016) argues, the increase in competition among peers of high cognitive standing, lowered other students' self-perception of their academic competence. High-ability, non-*Mawhiba* students had the least positive self-perception (Batterjee, 2016), as they felt intimidated by the higher academic

achievements of the *Mawhiba* scholars. Consequently, the enhanced curriculum in most schools was delivered to *Mawhiba* scholars only.

Enrichment classes in mathematics and the sciences were mandatory for the *Mawhiba* scholars, employing pedagogical strategies used in UK schools and steering their talents towards careers within the STEM fields (Mawhiba, 2015). Additionally, the King Abdallah University of Science and Technology (KAUST) Gifted Student Program offers scholarships to high school graduates, to study undergraduate STEM majors in the USA (Islam, 2014); oftentimes, these graduates are also Mawhiba scholars. According to Alharby (2012), the focus in Saudi Arabia is to identify the potentially gifted and talented students in science and technology and build a national database of high ability students for future use by educational institutes. Unlike programs for the gifted and talented in other countries, *Mawhiba* thus fails to cater for students who are talented in non-scientific fields.

One key feature of the *Mawhiba* program was the tailored environment of Summer enrichment programs (Alharby, 2012) exposing students to high quality enrichment programs, for example, Robotics, introduction to Biomedical Sciences, Engineering Design and Electrical Engineering (Alghamdi and Hassan, 2016). The creation of a suitable learning environment, based on interactions and communication that are free of anxiety and stress, is an important contributing factor to the development of critical-thinking skills (Alghamdi and Hassan, 2016). Batterjee (2016) and Alghamdi and Hassan (2016) agree that residential summer programs would be beneficial but anticipated the reluctance of Saudi parents to sending their daughters to such programs. However, more recently, the number of residential STEM programs organized through *Mawhiba* partnerships has increased (Carlson-Wood and Poole, 2018), showing a shift in parental perspectives on residential education. In addition, participation in robotics competitions often involves teams travelling to and residing in the location of event, for the duration of the competitions, and this is now widely accepted by those parents.

2.7.6.2 Robotics

Robotics is one of the major technologies of the future, an attractive platform for training young scientists and inventors (Margheri, 2016). It has gained popularity in the Gulf Cooperation Council (GCC) and is supported in Saudi Arabia by the MoE. Robotics has enabled *Mawhiba* scholars, as well as students within participating schools and universities, to engage in engineering and technology (Witherspoon *et al.*, 2016) and a range of national and international robotics competitions (Jazzar, 2015). The number of participating students is limited, and selection criteria vary within schools.

2.7.6.3 Saudi Women in Technology Program (SWTP)

Saudi Women in Technology Program (SWTP) is a unique example of a STEM enrichment program. In 2010/11, I collaborated with Massachusetts Institute of Technology (MIT), in Boston, USA, to organise the SWTP (CCWCE, 2011). The SWTP was a pilot summer program that aimed to expose Saudi Arabian girls to the application of math and science in the field of engineering. The program was carried out in MIT's Mechanical Engineering department in July 2011, coinciding with the annual MIT Women in Technology program (Skier and Hughey, 2015). SWTP was a two-week residential program that comprised a week of academic classes and technical tours, followed by a week creating a Rube Goldberg machine. Six Saudi Arabian 11th grade girls from the same private school attended the program. These included three *Mawhiba* scholars and three academically high achievers who were chosen because of their ability, curiosity, and parental consent.

Each participant had their own perspective on the outcomes of the SWTP. The following are two excerpts from speeches they presented in January 2012 at the Center for Clean Water and Clean Energy Forum hosted by Effat University about their experience.

> The two weeks I spent in the SWTP program were the most inspirational weeks of my life! When I first arrived there, Engineering was not my first area of interest. However, I was curious. I wanted to explore everything. Mostly, I wanted to go into a major that impacted people greatly. I thought that could only be done by going into law or a political field. However, my experience at MIT proved the contrary (Student 1).

Career education and early exposure to diverse occupations are highlighted by Student 1, in line with recent research in the UK (Archer *et al*., 2012). Student 2 focused on attracting students to engineering, by cascading the knowledge gained during the SWTP.

> Rube Goldberg is a highly over-engineered machine that performs a very simple task in a very complex fashion, including a chain reaction. I heard that Chinese students are creating [them for] their homework and American students are creating [them] as projects, then why not Saudi students? This is what made me decide that I should apply the knowledge that I gained during my trip to MIT to the practical world and [enable] the younger girls in my school to get acquainted with the Rube Goldberg project and get them interested in the field of engineering. The first step was to get the school girls interested in the idea, I didn't want them to think that they will be working with math or physics, I wanted them to realize that they are going to apply these subjects in creating a machine (Student 2).

Interestingly, the approach taken by Student 2 drew attention away from the academic subjects being utilised in the project by concentrating on generating students' interest. Mills (2013) points out that, in reality, not only do workers use situated, informal mathematical

strategies, but they also do not typically see themselves as “doing mathematics” in their work even though an outsider can find mathematics in most of their activity (Mills, 2013). Similarly, the complex math and physics skills required for Rube Goldberg projects were secondary to the creation of the machines.

Extracurricular STEM initiatives in Saudi Arabia tend to be selective and aimed at the most academic students, to develop their skills and interest in pursuing STEM careers. Time was a limiting factor for the SWTP participants and mechanical engineering was not available for girls in Saudi Arabia at that time, so their final career choices did not change; they entered medicine, computer science, business, law, and genetic engineering. School partnership data for the MSPI graduates 2012-2014, male (170) and female (73) indicated that most of the scholars entered STEM fields or medicine in university (Mawhiba 2015b). Further research in this area is needed to determine if, and to what extent, involvement in enrichment programs influences the aspirations of the Mawhiba scholars.

2.7.7 Higher Education Provision and Access

2.7.7.1 Higher education in Saudi Arabia

When King Saud University in Riyadh opened a women’s campus in 1979, a limited number of subjects were offered: Arabic, English, history, and geography. A year later, colleges for medicine, dentistry, nursing, and education were established (Hamdan, 2005). Hafiz (1990) found that female Saudi university students preferred home economics as a major, and teaching as an occupation in 1998/99. However, three decades later, Saudi women are pursuing higher education and professional careers in a diverse range of fields (Islam, 2014; Parveen, 2014) although teaching is still considered the most suitable profession for women.

Saudi Arabia is continuously investing in its education infrastructure, including improvements to several women’s universities and the opening of new colleges (Siegmund *et al.*, 2016); currently, there are twenty-six government universities in Saudi Arabia (MoE, 2017). Students’ tuition is paid by the government, resources are provided, and, in addition, students receive a fixed monthly stipend. This increases accessibility to higher education for all citizens and is a contributing factor to the high levels of enrolment.

In 2011, 53% of university graduates in Saudi Arabia were women, higher than most countries, whilst 22% graduated from overseas (MoHE, 2013). By 2017, female enrolment in Saudi universities was 66.7%, compared to 66.5% male (UNESCO, 2017). MoHE (2013) data shows that the annual growth rate of new undergraduates in Saudi universities between 2009 and

2013 was 14.6% for men and 10.6% for women. According to Hamdan (2013), the expanding population pressured the government to meet the growing demand for universities places by increasing the number of higher educational institutions. Thus, an immediate solution was necessary to manage the extremely young population, rising university enrolment, and unemployment levels (Lindsey, 2010).

2.7.7.2 Saudi Arabian students in higher education abroad

The King Abdullah Scholarship Program (KASP) was created in 2005, when "Saudi Arabia embarked on an ambitious program to offer its young citizens educational opportunities unparalleled in its history" (El-Showk, 2017: S64). KASP provided Saudis with opportunities for undergraduate and postgraduate studies at universities abroad, mostly in the USA, UK, Canada, and Australia, with fully-funded tuition and living expenses for up to four years (Gallarotti, 2013; Pavan, 2013; Parveen, 2014; Reda and Hamdan, 2015). Thus, the demand for university seats in Saudi Arabia was temporarily relieved and a desire to bolster cultural exchange was achieved.

Students chose courses from those approved by the government, to ensure that no particular industry would be saturated when students returned to Saudi Arabia to work (Taylor and Albasri, 2014). Between 2005 and 2014, the number of Saudi students in the United States increased from 5000, to 100,000 (Naffee, 2014; Taylor and Albasri, 2014), as part of the Saudi government 25-year plan to improve higher education opportunities, boost scientific research and tackle the country's shortage of scientists in critical fields (MoHE, 2010). In 2017, the number of Saudi STEM students in the USA was 25,125 out of 55,806 students in total (ICE, 2017). Tough KASP acceptance criteria have been proposed (Siegmund *et al.*, 2016) that would require future graduates to return home and contribute to achieving the 2030 Vision. Previously, KASP graduates were not obligated to return to Saudi Arabia and work, resulting in a loss of talent at the government's expense.

2.7.7.3 University preparation

The transition from high school to higher education encompasses a complex array of changes for students (Briggs *et al.*, 2012). Transitioning was identified as a cause of anxiety when Saudi students switch from primarily rote methods of instruction in the high school system to Western-influenced teaching methods at university (Al-Saraj, 2014), and English language as the medium of instruction. Hall (2013) mentions that between 2008-2010 the dropout rate of Saudi students in overseas and national universities was in the region of 30%. Coertjens *et*

al. (2017) argue that this transition period may begin in the last year of high school and extend until after the first assessment. Furthermore, they note:

> The difficulty of making sense of the courses discouraged some of the students from engaging in the programme because their perception of the programmes did not match their expectations (p.431)

Briggs *et al.* (2012) propose that schools, and higher education institutes adopting an integrated system of transitions, would facilitate students' higher education identity development and academic achievement. One approach used by Power and Hibbert (2016) found that student-led communities of practice in Australia benefit transitioning students and their peer mentors. Female mentees were most effective in supporting female engineering students in the USA (Dennehy and Dasgupta, 2017). Peer mentoring was most advantageous in the initial weeks of the transitions (Collings *et al.*, 2016), as it created a sense of becoming a university student (Power and Hibbert, 2016). Dennehy and Dasgupta (2017) concluded that peer mentoring yields dividends over time, as it promoted student retention.

Saudi students faced academic challenges due to lack of preparation, particularly in English reading and writing skills (Hall, 2013), family issues, and aversion to traditional teaching styles (Abdul-Ghafour, 2010). This drew the attention of the government and led to the introduction of foundation year programs for students entering Saudi universities, and orientation programs for students prior to travelling overseas were implemented (Abdul-Ghafour, 2010). It is surprising that, whilst university administrators recognised the shortcomings of the secondary school graduates, they urged a solution from within universities rather than schools, inferring that schools are not equipped to advise students about higher education. However, schools have a greater reach to all students; thus, a void remains for students not intending to pursue higher education.

2.7.7.4 Access to higher education

Due to the limited number of universities, many male students commute or relocate within Saudi Arabia to have access to higher education. For female students, the inability to be geographically mobile can limit their access to higher education institutions (Alsubaie and Jones, 2017). Although some courses are available through the university e-learning platforms, this method of study is not suitable for all majors (Al-Shehri, 2010; Alhareth *et al.*, 2015; Quadri *et al.*, 2017). In case the *Mahram* agrees for a girl to study away from home, the universities have secure, female only living accommodation. Yet, the belief from the wider society according to Hamdan (2012:593) is that "A good girl does not live away from her father's house."

For Saudi Arabian women, knowledge was not always associated with paid employment, according to Hafiz (1990), since many viewed higher education as a route to unlock themselves out of the traditional roles of daughter, wife, and mother. Furthermore, in Saudi society and culture, a woman's primary role was that of a nurturing mother and housewife. The purpose of education was for girls to learn how to be a better homemaker and mother (Baki, 2004; AlMunajjed, 2009; Aguirre *et al.*, 2012). Thus, social attitudes did not encourage a public role for women, and oil wealth, as mentioned previously, enabled the situation to persist. The Saudi governments' recognition that oil wealth is not infinite, compounded with globalisation, has slowly changed social attitudes to be more accepting of the role of Saudi women in achieving a knowledge economy

The literature reviewed barely mentions Saudi women in STEM education and careers, despite the number of Saudi women who have achieved recognition as pioneers in a variety of fields, most prominently science and research. These achievements are unmatched by many in the Arab world, including their male counterparts (Department of Planning and Statistics, 2010). The next section outlines the employment situation of Saudi women.

2.8 Saudi Women and Employment

Saudi women now seek education for its intrinsic value, the status it conveys, and the prospect of a fulfilling job, which may be a luxury for some, but an economic necessity for others. Although the government supports the education of Saudi women, this is still not fully reflected in the current workforce (Littrell and Bertsch, 2013; Islam, 2014), and particularly, in STEM careers. Previously, the low participation of women in the workforce was attributed to limitations imposed by the government, declaring cultural, social, and Islamic unsuitability of some jobs such as working in industry, law and as Shoura Council members (Al-Asfour and Khan, 2014). In 2005, only 5% of the total working-age female population was in paid employment (Parveen, 2014); this increased to 22% by 2010 (Hausmann *et al.*, 2010) although the type of jobs was not specified.

2.8.1 Socio-cultural Perspectives

A quantitative study on Saudi women's participation in national development (Omair, 2012), revealed that the majority of the Saudi participants (1502 male and 1502 female) viewed women's participation in the workforce positively, but expressed their preference for part-time work in gender segregated environments. These findings indicate a shift in social attitudes towards Saudi women participating in the labour force while still maintaining gendered

spheres. Omair's study was important in determining the trend from the male perspective, as a *Mahram* can either support or prevent women from seeking employment even when he has supported them in pursuing higher education (Rutledge and Shamsi, 2016). Yusuf (2014) argues that the problem of women's unemployment is a threat to the future development of Saudi Arabia, though prevailing cultural reservations were exposed in Omair's study. For most respondents, it was preferable for women to work in female sports clubs, in the healthcare and nursing sector, or to work remotely from home, followed by catering in restaurants, working in amusement parks, and working as ministers, pharmacists, diplomats, and security officials at the holy sites. Less than half of the respondents felt that women working in factories, as cashiers, or in Sharia courts was acceptable (Omair, 2012). Notably, STEM careers were not included in the suggestions.

The Saudi 2030 vision acknowledges that there are reasons other than women's rights to promote female workforce participation, such as development and nation-building (AlMunajjed, 2009; Fatany, 2013; Pavan, 2013; Parveen, 2014). Women stand to benefit from "Saudization," as companies are obligated to hire and train locals, and reduce the dependency on expatriate labour, especially for higher-skilled positions (Lindsey, 2010). Saudi feminization is another measure employed by the MoLSD to create jobs specifically for women (Parveen, 2014). Policies supporting the employment of women in diverse fields, including engineering, were implemented in 2005 (Kinninmont, 2017) and serve as the basis for new initiatives outlined in the Saudi Arabian Vision 2030 (Al-Saud., 2016).

Mobilizing the active participation of graduates into the workforce is a challenge in the Gulf region, as they prefer public sector employment (Marmenout and Lirio, 2014; Rutledge and Shamsi, 2016; Al-Asfour *et al.*, 2017; Al-Khudair and Pritchett, 2017), the attractive salaries and shorter working hours (Al-Asfour and Khan, 2014; Al-Asfour *et al.*, 2017). In 2010, most employed women worked in the public sector and 78.3% of the unemployed women were university graduates (Islam, 2014; Ministry of Economic, 2014). Currently, most jobs opportunities are available in the private sector, as the number of graduates exceed the available public sector jobs. Interestingly, Kinninmont (2017) reported a significant growth in the number of Saudi women employed in the private sector, but there is no indication if these jobs were created specifically for women (feminization) or made available through Saudization. Specific labour market outcomes are not necessarily the result of individual choices (Tomlinson *et al.*, 2013). Thus, it is difficult to conclude from Kinninmont's report whether attitudes have really changed or if the increase reflects women's agency in embracing different opportunity structures to increase their employability.

2.8.2 Female-only Work Spaces

Profanter *et al.* (2010) argue that the presence of men in the workplace is an unfamiliar reality for most job-seeking Saudi women, since education is delivered in women-only settings. Research indicates that most Saudi women prefer female-only work spaces, where they can pursue careers without violating cultural boundaries (Khoja, 2016) and integrate socially with their colleagues. This suggests that the infrastructure needs more female-only workspaces to accommodate the increasing number of unemployed women (Omair, 2012). However, the establishment of female-only spaces is costly since all facilities must be duplicated (Al-bakr *et al.*, 2017), imposing a financial burden on some private companies. A small, but growing, number of women are working in companies that are not totally gender segregated, but uphold Islamic values (Khoja, 2016). Interestingly, Green, Ackers and Black, (2002, cited in Bennett, 2011) found that women working in engineering in the UK preferred female-only work spaces, which would facilitate female sociability. Additionally, these work spaces would enable them to cope within the male dominated field without working in mixed teams, thus reinforcing patriarchal norms which they are simultaneously challenging. This indicates that social integration is important for the retention of women in STEM fields (Caprile, 2012).

2.9 Careers Guidance

Aspirations reflect one's motivation to achieve or succeed. Students need to have a good picture of the job market and where they need to put their efforts in studying to be able to realise their dreams (Musset and Kurekova, 2018). Social Cognitive Career Theory (SCCT) highlighted the correlation between achievement and career choices (Lent *et al.*, 1994) and how internal and external factors influence career decisions (Fouad *et al.*, 2010). Many elements that influence student's decisions towards educational and career paths have been identified by researchers. These include a combination of aspirations, expectations, and school achievement (Khattab, 2015), mothers, teachers and significant others (Whitbread, 2003; Gunderson *et al*., 2012; Harackiewicz *et al*., 2012; Taylor, 2015), self-belief (Sheldrake *et al.*, 2015; Mujtaba *et al.*, 2018), utility value of subjects (Whitbread, 2003; Gunderson *et al*., 2012; Harackiewicz *et al*., 2012; Taylor, 2015), enjoyment (Foote and Garg, 2015), perceived difficulty of subjects (Sheldrake *et al.*, 2015; Taylor, 2015), pre-high school experiences (Sadler *et al.*, 2012), and high school occupational aspirations (Morgan *et al.*, 2013; Archer, 2016). Khattab (2015) argues that aspirations reflect individuals' hopes for the future and may be realistic or unrealistic unless expectations and achievement are considered.

For students and especially girls, high mathematical ability is an important factor when considering pursuing STEM programs (Hango, 2013; Wang *et al.*, 2013; Wang and Degol, 2017). Research has indicated that students in the USA experiencing mathematical anxiety perform poorly on standardised tests (Devine *et al*., 2012; Anis *et al*., 2016) or avoid mathematics (Ashcraft, 2002; Cropp, 2017). This suggests that low mathematical ability and high mathematical anxiety may adversely affect students' decisions to pursue STEM majors. Girls with high mathematical abilities are more likely to pursue STEM subjects (Wang *et al.*, 2013). Research has shown that students who switched from STEM to non-STEM college majors had verbal ability as strong as their math ability; they switched to equally intellectually challenging but less math intensive majors e.g. Law, as noted by Dweck (2008) and Wang *et al.* (2013). This suggests that a wider range of career choices, rather than lack of ability, affect girl's career intentions post high school (Wang *et al.*, 2013).

2.9.1 Career choices in the UK

2.9.1.1 Subject choices

Students in many western countries have some freedom to select the subjects that they want to pursue when they reach the final years of high school. Yet, in the UK, it is compulsory for all local authority-maintained schools to teach students sciences and mathematics until the age of 16 where these subjects may result in General Certificate of Secondary Education (GCSE) award, along with some other compulsory subjects. At this point, students have several options, with the most academic pursuing advanced courses e.g. A' levels in their chosen subjects (Gill and Bell, 2013). Students are often guided by parents, teachers, counsellors, and friends in making these choices, based on their interests, recognized abilities, and intended educational or career paths (Fouad *et al*., 2010; Hooley *et al*., 2011; Ofsted, 2011; Ikonen *et al*., 2018), though parents may not be familiar with the new qualification and employment opportunities available in the UK (Haynes *et al.*, 2013) and friends may not be better informed. This suggests that these parties can positively influence the uptake of STEM subjects if they are well informed (Harackiewicz *et al*., 2012) and if mothers feel confident that careers like engineering would provide supportive working environments (Macdonald, 2014).

Career path decisions are susceptible to societal and environmental influences (Silim and Crosse, 2014). Adamuti-Trache and Andres (2008) note that in all education systems, it is possible to leave science pathways as early as grade 11. Thereafter, students with insufficient science qualifications may be prevented from enrolling in STEM courses. Consequently, secondary educational systems with few mandatory requirements may intensify the low

uptake of STEM careers (Adamuti-Trache and Andres, 2008; Silim and Crosse, 2014). Furthermore, Dewitt and Archer (2015: 2186) note, “In many English schools only the highest attaining students are allowed to pursue more rigorous science courses (or any science) as they proceed through the school system.” and Crosse, 2014). Furthermore, as However, other students can pursue vocational qualifications in STEM-related subjects. This provides an alternative route to STEM-related careers and higher education. In the UK and USA, post-secondary school Institutes such as colleges can provide indirect routes to bachelor’s degrees in STEM fields (Adamuti-Trache and Andres, 2008).

2.9.1.2 Career choices

Motivations to work with others, and to make a social contribution, are amongst key determinants for the career choices of girls (Eccles, 2013). Females are more likely to be drawn to occupational fields involving tasks that are perceived to fulfil these values (Su and Rounds, 2015). Families who had more science capital (science-related qualifications, understanding about how science works, knowing someone who works in a science-related job) are more likely to have positive aspirations about science. However, parents and students can have a narrow view of where science can lead (DeWitt and Archer, 2015), but, parental influence plays a role in career-decision making and can carry more weight than either that of career counsellors or educators (Creamer and Laughlin, 2005). However, Musset and Kurekova (2018) point out that when career guidance services are effective, they can be expected to have a positive influence on the educational and employment outcomes for young people.

The decline that occurred in the UK industrial and manufacturing employment sectors in the 1980s incurred a need for students to gain qualifications and mobility in order to secure employment (Haynes *et al.*, 2013). Previously, children would often follow in the footsteps of their parents, work in the same companies, doing the same jobs. Their exposure to gendered stereotypes often began at home by observing and mimicking their parents (Shapiro *et al.*, 2015). Rutledge (2017) suggests that parental relational support plays a crucial role in the development of adolescents' succession motivation to join the family business. By learning from direct experience that occurs through observation of other people’s behaviours and the consequences of them and receiving advice and help from their parents (Rutledge, 2017). Gender role stereotypes influenced by family and friends are established as early as age two and a career identity emerges by middle school (Jantzer *et al*., 2009; OFSTED, 2011). This can lead to the preservation of unskilled low waged jobs or high career aspirations within

families, according to lower socio-economic and affluent backgrounds, respectively (Haynes *et al.*, 2013).

Students from more affluent backgrounds tend to have higher aspirations, as they benefit from family and community social capital, parental engagement with school, and educational support beyond school (Khattab, 2015; Leithwood and Patrician, 2017), which makes achieving their aspirations easier. Family educational capital also presents itself through the experiences of and conversations with older siblings (Zhang and Barnett, 2015). To increase access to higher education recent studies have recommended equipping parents from low SES backgrounds with skills to support their children (Fischer *et al.*, 2017). Increasing parental engagement can lessen differences in socio-economic status (SES) and family background (Leithwood and Patrician, 2017). Undeniably, this is a positive step towards parents supporting their children. However, the interventions should be sustained until the desired outcomes are achieved, as isolated interventions are less likely to be successful.

2.9.2 Careers Guidance in the UK

High quality unbiased careers guidance and experience in school are critical elements in students' subject choices. Hooley *et al.* (2013) emphasize the importance of early career development in schools, including work experience. This will ensure students' smooth transition from school to the labour market or higher education and improved educational, social and economic outcomes (Musset and Kurekova, 2018). Work experience and other forms of employer engagement demonstrate to young people the connection between what they learn in school and how those skills will be used in the labour market. Yet, students often satisfy the work experience requirement without truly linking those experiences to their future careers (Macdonald, 2014).

The provision of careers education, information, advice and guidance by schools in the UK is inconsistent (Archer and Moote, 2016), for example, in the OFSTED (2011) report, girls from almost half of the secondary schools in the report (11 out of 25) claimed that they were not sufficiently informed to make essential choices. Archer and Moote (2016) found that less than two thirds of Year 11 students have received careers education, with boys receiving more careers education than girls. Furthermore, schools did not consider gathering feedback from former students on how careers support could be improved (OFSTED, 2011). This suggests that greater effort should be expended by all schools to encourage uptake of non-stereotypical courses by girls and to incorporate careers education in primary school onwards, as recommended (Archer *et al.*, 2013; Silim and Crosse, 2014). Silim and Crosse (2014) suggest

that teacher training courses include equality and inclusion training to understand and deconstruct gender stereotypes which may also include their own unconscious predispositions. As Shapiro *et al.* (2015) argue, stereotypical exposure occurs through the media, and books and educators may subconsciously influence students.

The role of schools in providing quality careers education, information, and guidance is challenging, with concerns about its effectiveness in providing support for all students in England (Moote and Archer, 2017). The Gatsby report presents eight benchmarks for good careers guidance in schools (Holman, 2014). Most schools have only achieved one or two, but none have achieved all eight**.** Musset and Kurekova (2018) argue that careers guidance services in school and outside have a formative influence on how young people understand themselves and the world of work. Careers guidance should enable students to make informed decisions by directing or providing them with accurate descriptions of careers and the work environment. Bloomfield (2017) argues that perceptions of engineering, even on popular search engines, are exceptionally out-of-date and do not adequately reflect that the industry is becoming more reliant on the benefits of the digital age. One strategy employed in most UK schools to improve student understanding of the relationship between education and employment is work experience. Students in the last two years of compulsory education in the UK are eligible to gain hands-on work experience at an employer's premises, typically for one or two weeks. Work experience can provide a valuable strategy for creating positive attitudes towards work and can influence students' career choices. The ASPIRES 2 project highlighted the inconsistencies in work experience provision by schools, where boys and students with higher cultural capital tend to receive the most career education and engage in work experience (Archer and Moote, 2016). Archer and Moote (2016) also found that whilst a significant number of students with high science aspirations received career education, they were significantly less likely to have undertaken work experience. This suggests the need for stronger collaborations between schools and STEM related industries with the inclusion of work experience opportunities for students.

2.9.3 Career Guidance and Career Choices in Saudi Arabia

2.9.3.1 Family Impact

Within a culture of close-knit families where the viewpoint and advice of the elders is respected and taken into consideration, there is a more direct impact on career choices than in families that encourage individuality and independent decision-making (Dimitriadi, 2013). Parents from lower socio-economic backgrounds may view education and careers as routes to upward

social mobility (Basit, 2012), as occupational roles locate individuals in the wider social space (Treiman, 2013). Yet, these parents may not associate education with employment except in certain fields like medicine (Basit, 1997; Dimitriadi, 2013). Treiman (2013:1) argues: "Every adult member of society ordinarily is able to locate occupations on a hierarchy of prestige." A survey of 15-year-old students in 72 countries revealed that medicine was the most popular profession that they aspired towards, followed by teaching (Musset and Kurekova, 2018).

Prior studies concentrating on ethnic minority families pointed toward a relaxing of previous restricted choices, e.g. Muslim girls in the UK expressed that generally parents would be happy for them to continue in post-compulsory education (Archer, 2002). However, Basit (2012) argues that family pressure to choose better educational and career options are still prevalent, which supports earlier findings by Mellors-Bourne *et al.* (2011). Rutledge (2017) maintains that some children are stimulated to develop a self-motivation by parents. Particularly, in the case of family businesses, they may be encouraged to explore other vocations, but findings suggest that they eventually join the firm (Rutledge, 2017). Parents function as both role models and conditioning agents of socialization, providing knowledge and experiences concerning their children's possible future adult roles (Claster and Blair, 2017). Additionally, in countries where structural constraints may hinder access to education and careers, parental support significantly reduced the magnitude of sociocultural barriers (Rutledge, 2017).

2.9.3.2 Career guidance in Saudi schools

Saudi Arabian public schools employ student counsellors whose responsibilities combine three main aspects of counselling: educational, vocational, and personal (Alghamdi and Riddick, 2011). However, guidelines for the implementation of counselling programs are not clear and are largely dependent on the principal's perceptions of the counsellor's role, which tend to concentrate on social and behavioural problems. Inconsistences are evident between the actual and ideal functions performed by counsellors (Alghamdi and Riddick, 2011). Barnett (2015) argues that the approach to presenting career options in Saudi Arabian schools remains fragmented and unstructured. Saudi Arabia does not have a strong history of career development (McCarthy and Hooley, 2015); consequently, there is a lack of literature and resources concerning career guidance and career counselling in Saudi Arabia (Hooley, 2017), specifically for high schools.

According to university administrators, secondary school graduates need guidance to apply their skills and capabilities to select subjects that suit them (Abdul-Ghafour, 2010). Teachers'

knowledge and understanding of careers and the related STEM labour market should be enhanced so that they are better able to support students' career-related learning (Badri *et al.*, 2016). Policymakers have focused on interventions that target university graduates although school-aged students need guidance to be able to conceptualize what a 'career' is (Barnett, 2015; McCarthy and Hooley, 2015). SWTP participants expressed that the prospect of studying engineering would have been greater if they had been exposed to engineering earlier. The program highlighted the need for practical skills development and early access to information about a range of careers, as argued by Silim and Crosse (2014).

Technology has facilitated accessibility to careers information; the internet serves as a careers library through which individuals can search and source information, for example, about what different jobs involve (Koštálová *et al.*, 2017). Nevertheless, often the information tends to be relevant to western countries, referring to qualifications irrelevant to the Saudi context. As Koštálová *et al.* (2017:10) state:

> Sometimes the information which young people find on the internet can be less than helpful. They need the knowledge and skills to interrogate online information and make decisions about whether the information is relevant.

Therefore, despite the benefits of using the internet for careers research, students need guidance to understand where career information from one part of the world may not be applicable in Saudi Arabia. For example, the school leaving age and type of qualifications vary across the world. According to UCAS, successful completion of the Saudi Arabian Tawjihiya (General Secondary Education Certificate) with an overall pass mark of 80% or above in relevant subjects is equivalent to 5 GCSE passes (UCAS, 2014). Consequently, a 12th grade Saudi graduate is not eligible for direct entry onto undergraduate degree courses in the UK. Furthermore, the types of careers available to girls in the West is unlimited, whilst the Saudi labour law prevents the employment of women in hazardous professions (MoLSD, 2017).

In Saudi Arabia, the Human Resource Development Fund (HDRF) initiative aims to prepare people for the labour market. It is an online platform which offers a range of programs, including career counselling services and summer training (work experience) that is conducted in private sector establishments. The Summer Training Program "*Saifi*" provides male and female students with basic skills, which enables them to work and to gain knowledge about the labour market (HRDF, 2017).

Some universities and industries have collaborated and introduced career options to undergraduate students through annual career fairs, and graduate opportunities are

showcased in an annual job fair (Taylor and Albasri, 2014). Engaging female Saudi scientists as mentors could prove to be inspiring, helping to demystify cultural barriers that girls may anticipate, providing tangible examples of working in science careers outside academia (Aguirre *et al*., 2012; Foote and Garg, 2015). Salim and Crosse (2014) argue that connecting students with mentors can help to address students' perceptions about STEM. However, the low participation of women in the workforce represents a loss of knowledge, skills, and investment in training, resulting in fewer female mentors who can help young female scientists with their career choices (David, 2011). A one-to one meeting with professionals, like the kind suggested by OFSTED (2011), could be effective but costly.

2.10 STEM Education and Careers

The acronym STEM was first coined by Dr Judith Ramaley in 2001 at the National Science Foundation (NSF). She defined STEM as an educational inquiry where learning was placed in context, and students solved real-world problems (Daugherty, 2013). STEM education integrates concepts that are usually taught separately and focuses on the applications to real-life situations (Banks and Sokolowski, 2010) but in reality, STEM is usually interpreted to mean math or science and rarely refers to technology or engineering. A high degree of ambiguity has surrounded what STEM education means, how it is delivered (Bybee, 2010), and what types of majors and careers are classed as STEM (Banks and Sokolowski, 2010; Breiner *et al.*, 2012; Kimmel *et al.*, 2012). Many acronyms have surfaced over the years, leading to debates about the representation or underrepresentation of other disciplines. Advocates of the integration of art/arts into STEM argue that art and creative approaches will contribute to the effectiveness of STEM education and introduced STEAM (Science, Technology, Engineering, Arts and Mathematics) education (Daugherty, 2013; Colucci-Gray *et al.*, 2017).

Despite the complexities of STEM education, one of the driving forces behind its progression is largely the potential economic benefits for countries in securing a competitive edge in research and technology capabilities for the future (Ramaley, 2009). On the other hand, the purpose of STEAM education, although gaining popularity, is less clear beyond education and has not garnered the same level of interest at the political level as STEM (Colucci-Gray *et al.*, 2017). Another contentious aspect of these acronyms was the omission of medicine as a field within STEM (Kimmel *et al.*, 2012). Miller and Solberg (2012) maintain that most research on careers in STEM and medicine are artificially segregated and they combine these two strands into one, STEMM (Science, Technology, Engineering, Mathematics, and Medicine). Eccles (2013) argues that the deviations in the definitions of what constitutes STEM can lead to variations in the number of girls participating in STEM.

Despite a growing need to develop capabilities in science, technology, engineering, and mathematics (STEM), many men and women who are considered talented in these areas during high school choose not to pursue STEM undergraduate majors (Heilbronner, 2011). Internationally, a minority of young people report desires to pursue a career in science (OECD, 2015), the low uptake in STEM subjects created a fear of a skills crisis in future generations in the UK (Smith, 2010), the USA (Beede and Julian, 2011) and Europe (Hutchinson, 2014). Whilst government rhetoric focused on the impending shortages in the workforce, qualified engineers in the UK are unemployed (Smith and Gorard, 2011; Morse, 2018). More recently, analysis of the labour market in the USA confirms a STEM crisis in specific fields within industry, and a surplus of STEM related PhD holders in academia (Xue and Larson, 2015) and in the UK (Smith, 2017a). Smith (2017a) and Rothwell (2013) argue that there is lack of empirical evidence to support the STEM workforce shortage claims. Furthermore, Morse (2018) reports that the evidence indicates that there is a STEM skills mismatch rather than a simple shortage. Regarding women's participation in STEM fields, Wang and Degol (2017) assert that math-intensive fields are among the only STEM fields in which women have not yet reached parity with men. This suggests that either interest and participation in STEM fields have significantly increased or the claims of shortage were incorrectly generalized across all rather than specific STEM fields, which is in line with the current findings of Smith (2017a).

2.10.1 STEM Outreach

Previously, the correlation between high school subjects and progression to specific STEM careers was unclear except for a pre-requisite to possess background knowledge in science and mathematics (Ofsted, 2011; Macdonald, 2014). There is evidence of initiatives in some schools in the UK that have successfully inspired students to continue their early enthusiasm for science by progressing to STEM-related further and higher education (Watermeyer, 2012; OFSTED, 2015a; Aslam *et al.*, 2018). The increase in STEM-related initiatives in the UK may have contributed to the 1% increase in STEM subjects' higher education enrolment between 2015 and 2016 (HESA, 2017). Increased awareness through STEM intervention and outreach programs has generated an array of outcomes in the UK (Banks and Sokolowski, 2010; Breiner *et al.*, 2012; Kimmel *et al.*, 2012). Banerjee (2017) argues that participating in STEM enrichment initiatives did not increase the likelihood of post- compulsory education uptake of STEM subjects in the UK. However, Aljughaiman and Ayoub (2012) maintain that the timing of the interventions is crucial, as developing students' abilities needs to be sequential, therefore enrichment programs should not be envisioned as one-off programs.

Certain groups are underrepresented in STEM careers. Amongst these, girls and women have been identified as untapped human capital that could enhance the STEM workforce (Hutchinson, 2014). Hence, the underrepresentation of women in STEM careers is a global concern, as scientific advances are strategic to economic competitiveness (Beede and Julian, 2011; Huyer and Hafkin, 2012; Kelly *et al.*, 2014). The increase in college-educated women has augmented their share of the overall workforce (Abele and Spurk, 2011) but not in the STEM fields. Women in the USA occupy about 50% of all jobs in the USA economy, but less than 25% in STEM fields; similarly, 46% of the UK labour force are female, with just 13% in STEM occupations. The UK has the lowest participation of women in the STEM workforce in Europe particularly in engineering and ICT although according to the Women in Science and Engineering (WISE), between 2012-2014 women in the UK chose STEM occupations at a higher rate than men, illustrating 8.2% and 6.95% increases, respectively (Macdonald, 2014). The gender compositions of STEM fields vary internationally (UNESCO, 2015), indicating that more women pursue biology than computer science and engineering (Heilbronner, 2012; Hango, 2013; Science and Technology Committee, 2014).

Studies carried out to underpin the reasons for underrepresentation of women in STEM careers have indicated that social and personal factors including peer support, and social identities may shape youths STEM career choices (Leaper *et al.*, 2012; Robnett and Leaper, 2013). Furthermore, performance, interest, uninteresting subjects, unappealing job prospects, and preference for an enjoyable subject over one where they naturally excel, influence the scientific major choices and future career plans of females to differing extents (Foote and Garg, 2015). Although students enjoy science lessons and agree that STEM is important to society, making science lessons interesting is not enough for them to enter STEM careers (Badri *et al*., 2016). Other studies point to schooling experiences and curricula that focus on mathematics and science with little or no technology and engineering (Bybee, 2010; Border and Nath, 2013).

Interestingly, it has been argued that mathematics, as taught in school, has limited value in the future workplace, as the “role of mathematics in our society is not only growing, but that mathematics is also increasingly done by machines” (Gravemeijer *et al.*, 2017: S106). A similar argument is presented by Bybee (2010) with respect to technology; he notes that despite its growing influence in everyday life, it is given inadequate attention within school programs. From the perspectives of both Bybee and Gravemeijer *et al.,* education at all levels should reflect the informatization, automatization, digitalization, and globalization of the world. This indicates the crucial need for a review of mathematics and technology curricula, in

tandem to facilitate a shift towards teaching competencies that complement rather than compete with computer capabilities (Gravemeijer *et al.*, 2017). This would also alleviate the reported mismatch between graduate candidates' abilities, employers' requirements, and the ambiguity surrounding the skills requirement for STEM jobs (Mellors-Bourne *et al.*, 2011; Smith, 2017a). The lack of knowledge about STEM careers may suggest a lack of interest in, and motivation for, women to enter into STEM fields, thus perpetuating ideas of stereotypical gender roles (Bergeron *et al.*, 2006; Mann and DiPrete, 2013; Syed and Van Buren, 2014). Additionally, peer pressure to maintain traditional roles influenced some girls' decisions not to pursue STEM careers (Leaper *et al.*, 2012).

2.10.2 Single–sex education

Proponents of single-sex education believe that separating boys and girls, by classrooms or schools, increases students' achievement and academic interest. It nurtures girls to be more competitive (Fryer Jr and Levitt, 2010; Booth and Nolen, 2012), to develop personal confidence and actively participate in class (OFSTED, 2011). Schools are the main contexts within which gender comparisons would occur for subjects such as mathematics and physics, therefore students in single-sex schools should have fewer opportunities to make those comparisons than students in co-ed schools, thereby creating an empowering environment for girls (Pahlke *et al.*, 2014). However, Pahlke *et al.* (2014) report close to zero effect of schooling type on mathematics performance, although there were some benefits for girls; "Single-sex schooling appeared to produce no advantage in high school for either boys or girls. It showed a medium advantage in middle school for girls" (p. 1065). However, Winters *et al.* (2013) found that in middle and high school, girls benefitted from being taught by female teachers and boys were not disadvantaged, except in the case of mathematics. Thus, having a female mathematics teacher was of more benefit to the girls than boys (Winters *et al.*, 2013).

Lee *et al.* (2017) argue that both performance and subject appreciation rise when students are taught by a same-gender teacher, yet according to Cho, (2010) evidence suggests that assignment to a same gender teacher does not affect student performance. There is considerable variation in research findings (Yazilitas *et al.*, 2013). For instance, Cho's analysis of OECD countries may seem conclusive, but the nuanced differences in the students' environments and unobservable student traits may incur bias (Dee, 2007). On the other hand, evidence from Southern and Eastern Africa produced mixed findings, leaning towards traditional academic gender stereotypes; boys and girls perform better in reading with female teachers but perform better in maths with male teachers (Lee *et al.*, 2017). Generally, evidence from the US and European countries suggests limited or no effect of teacher gender on student

achievement, but where there is a positive effect the girls benefit more than the boys. What is apparent from the literature is that, whilst numerous factors have been addressed (Pahlke *et al.*, 2013; 2014), few studies have considered the relationships between teacher gender, student gender, and student achievement situated in entirely single-sex environments.

2.10.3 The Underrepresentation of Women in STEM Education

Examination of STEM workforces has given rise to an abundance of research in this area and findings initiated a need to address the lack of women in STEM related careers. Berryman (1983) introduced the metaphor the 'leaky pipeline' and it has since dominated the scientific literature on women in science. The leaky pipeline refers to the loss of women from the STEM fields at every stage of educational advancement; more women than men leak out of the pipeline (Berryman, 1983). The number of women completing advanced degrees in STEM fields decreases at each stage of higher education compared to those in non-STEM fields. In 2011/12, 61% of UK bioscience postgraduate students were female compared to just 15% of professors (Science and Technology Committee 2014). Langberg (2006) argues that the leaky pipeline did not apply to Dutch universities. The percentage of women among full professors increased from 3-10% between 1976 and 2003 (Langberg, 2006). Furthermore, Miller and Wai (2015) argue that the 'leaky pipeline' partially explains historical not current gender differences in the bachelor to PhD transition in the more male dominated STEM fields in the USA. Nonetheless, the chilly climate in academic and workplaces (Sandler and Hall, 1986) still exists (Jorstad *et al.*, 2017). Consequently, feelings of isolation and lack of support have been reported in the USA. Caprile (2012:8) notes that:

> Science and engineering professions seem less responsive to the social forces that are driving progress towards gender equality in other highly-skilled professions (physicians, lawyers...)

It is surprising that, despite the attention and urgency given to the underrepresentation of women in STEM fields, research shows that female students are unsure what types of careers in physics exist and expressed a lack of recognition for their scientific abilities (Foote and Garg, 2015). Similarly, Dimitriadi (2013) maintains that the lack of accurate and encouraging information deters women from choosing 'hard' sciences. Eccles (2013) suggests engaging role models to explain about STEM careers, emphasize how STEM careers help society (Su and Rounds, 2015), and gain an accurate perspective on the development and diversity of STEM fields (Bloomfield, 2017). The lack of female role models and mentors have been shown to limit the number of women in STEM fields (Xie and Shauman, 2003; Spelke, 2005; Phipps, 2008; Hutchinson, 2014).

Literature shows that girls benefit from exposure to female role models, and after exposure to female scientists, adolescents have a positive attitude towards scientists and women in science (Smith and Erb, 1986; Dimitriadi, 2013). Likewise, Betz and Sekaquaptewa (2012) found that exposure to successful, hardworking feminine STEM role models had a positive effect on college aged women. However, research also indicates that female guest speakers and discussions about female scientists' work were non-significant in influencing girls' development of a physics identity (Hazari *et al.*, 2010; Sadler *et al.*, 2012). It has also been argued that feminine STEM role models demotivated middle school girls' STEM interest relative to gender neutral role models:

> The feminine STEM role model is a well-intentioned attempt to counter these negative stereotypes that may not work as intended. An explicitly feminine STEM role model is more contradictory or unexpected than an everyday woman who excels in a male-dominated field (Betz and Sekaquaptewa, 2012:2)

Furthermore, girls who have an interest in STEM are more likely to aim for the success displayed by role models much more than those who do not; in fact, they may view the success as unattainable (Buck *et al.*, 2008). Consequently, these observations suggest that the timing of the exposure to female role models is crucial in encouraging or discouraging STEM interest. Early exposure to female role models is more beneficial for girls, before they have identified themselves as STEM students, rather than later when they have identified themselves as non-STEM (Macdonald, 2014).

Governments, schools, universities, employers and feminist groups are amongst those who have instigated initiatives to reduce the underrepresentation of women in STEM fields. Yet, Smith (2010) reports that three decades of initiatives have done little to increase STEM participation by women especially in physics and engineering. Macdonald (2014) suggests that these STEM interventions may be misplaced and inconsistent resulting in limited success. These initiatives used women-only training, a powerful tool in empowering women (Phipps, 2008) but the image of role models as superwomen is unrealistic according to Dimitriadi (2013) and may have negative effects on those who do not believe they will be able to balance work and family. Uncertainty regarding the working environment is also a concern addressed by the UK Resource Centre (UKRC) for Women in SET. UKRC was established by the Department of trade and Industry for shifting the focus of inclusion efforts away from earlier deficit model and toward challenging the 'Chilly Climate' (Sandler and Hall, 1986) in SET organisations (Phipps, 2008), but little is done to challenge the more structural and organizational barriers to retention and progression of women in SET (Huyer and Hafkin, 2012).

Other forms of inequality are also significant since class and ethnicity may be the consequence of barriers students face in the educational or STEM pipeline (Strayhorne *et al.*, 2012). Structural constraints on choices for children from ethnic minority backgrounds have prevented them from continuing in education/employment (Archer, 2002). Furthermore, young British ethnic minority students perceived that teachers had low expectations of them and they received inadequate careers advice and support (Basit, 1997; Parker-Jenkins *et al.*, 1997; Archer, 2002). The question of social class inequality in educational opportunities and outcomes, as explained by sociological theorist, Bourdieu, are considered to be important factors in explaining the gender gap in program choice (Werfhorst *et al.*, 2003; Murphy, 2013). The combination of all the science-related social and cultural resources, as defined by Bourdieu, amounts to Science Capital (Bourdieu, 1984; Archer *et al*., 2012).

Socially disadvantaged children may not achieve upward social mobility because of their parents' cultural capital being insufficient to provide the resources to help them build better socio-economic futures for themselves by realising their aspirations (Khattab, 2015; Stevenson *et al.*, 2017). Basit (2012) goes beyond the negative associations of social and cultural capital to highlight the contribution made by parents in the form of struggles and sacrifices to encourage and support the upward mobility of their children. Irrespective of socio-economic status women as potential mothers have additional factors to take into consideration. Research shows that science capital is more closely related than cultural capital to science-aspirations outcome variables such as science literacy and perceived transferability and utility of science (DeWitt *et al.*, 2016). Yet, efforts to increase science capital through specialised STEM programs, increasing awareness in schools and outreach programs has had little effect on the low rates of women embarking on a scientific career.

2.10.3.1 Work-life balance

One aspect of human capital theory holds that highly educated women are more likely to remain in paid work when they become mothers than their equivalents with less marketable skills (ONS, 2015) as they face higher opportunity costs of leaving the labour force (Becker, 1991). The tensions between family and careers are significant, as women report greater interest in raising a family, while men exhibit a stronger commitment to contributing to science (Sax and Harper, 2007; Ceci and Williams, 2012). Many young women believe that science is incompatible with family life (European Commission, 2012). The realities of the caregiving role and the impact it has on daily work and career progression are complex and vary with every family situation (Hardy *et al.*, 2018). Dimitriadi (2013) discovered that young girls were interested to find if the women in STEM careers they met had children and how they balanced

their careers and personal lives. According to Hakims Preference theory, women's lifestyles can be categorised into three main groups: work centred, often childless; home- centred, often having many children and little paid work; and the remaining majority combining paid work with raising children (Hakim, 2002). This assumes that all women work, regardless of having a family, which is not necessarily applicable to all societies or cultures. In societies where women have traditionally been concentrated in family work, like Pakistan, shifting to market work requires employing strategies to ensure that work-life balance is maintained (Naz *et al.*, 2017) and coping with the challenges of multi-tasking (Offer and Schneider, 2011). Contrary to Hakims' theory, increases in female access to education, and science and technology specifically, does not translate directly into increases in the number of females in the workforce (Huyer and Hafkin, 2012), indicating that additional factors were at play. From the Saudi perspective, family takes precedence over working, whereby women may choose to stop working until their children are school-aged or avail of the childcare provisions that the government have mandated for employers. These have significant effects on the career trajectories and working lives of the women.

2.11 Saudi Women in STEM Education and Careers

The STEM fields available for female undergraduate studies in Saudi Arabia are inconsistent across public universities except medicine, dentistry, the physical sciences, maths, and computer science. AlMunajjed (2009) mentions that the fields of education and training of Saudi women were limited, with science, engineering, and agriculture being reserved for men. Historically, certain fields, such as engineering have been dominated by men universally (Diekman *et al.*, 2010), indicating that the situation in Saudi Arabia was not exclusive. However, Reda and Hamdan (2015) argued that gender specialization in specific careers was based on the practicalities of Saudi women working in a gender segregated society, and "Women's degrees were intended to encompass fields they can pursue as careers in a conservative society" (p.671). Islam (2014) notes that, in 2004, women were encouraged by King Abdullah to seek jobs in fields that had previously been reserved for men. This was a significant turning point for women and their future career options. Al-Rasheed (2013) points out that the situation for women was changing gradually. Research shows that 80% of female students surveyed in Saudi Arabia are interested in engineering (Maffeo, 2013), but El-Sherbeeny (2014) indirectly addressed the probable resistance from Saudi society by proposing that:

> Engineering for females can also slowly be promoted and integrated into Saudi universities without the need for co-education or direct instruction of girls by male professors (p.6).

In 2013, two engineering disciplines were offered at one female public university in Saudi Arabia (El-Sherbeeny, 2014). However, a range of engineering disciplines are currently being offered at all female public universities which indicates that Saudi society find it acceptable for women to study these majors. According to the Global Gender Gap Report 2015, in Saudi Arabia, 38% of tertiary–level students enrolled in STEM studies were female, compared to 62% male (Hausmann *et al*., 2015). However, the number of Saudi women employed in STEM fields in Saudi Arabia is not reported. Employability is a growing concern, as graduate labour markets are becoming increasingly competitive (Grant-Smith and McDonald, 2018). Degree related work experience could provide an employment related advantage and encourage graduates to apply for STEM jobs in the long term. Furthermore, where mandatory work experience is a prerequisite for university graduation, it provides exposure to the work environment and forces more conservative families to allow girls into the workplace, as discovered in the United Arab Emirates (Marmenout and Lirio, 2014). It may also alleviate parental concerns about the atmosphere in the workplace (Macdonald, 2014).

As mentioned previously, Saudi women are also pursuing degrees overseas where the range of STEM majors is vast. Islam (2014) reports that Saudi women are becoming pioneers in a variety of fields, most prominently in science and research. They are receiving international awards and being granted patents for their ideas and innovations (Department of Planning and Statistics, 2010; Islam, 2014). What is not clear is how many Saudi female scientists are involved, as the news of awards is not adequately publicised.

2.12 Summary and Conclusion

STEM has been identified globally as an area that countries should develop to secure their economic futures. Ambiguity surrounds the definition of STEM, the integration of its components and the careers represented by it. Recent research indicates that there are shortages in certain STEM fields. However, motivated by initial fears of a shortage of skilled STEM workers, numerous initiatives have been developed to encourage the uptake of STEM careers. In line with gender-equality goals, an increase in the women in STEM careers is the aim in many countries, though a complex range of factors render STEM careers less favoured than non-STEM careers. Consequently, initiatives have had limited impact. The literature highlights the challenges and concerns related to women in STEM in secular societies, mainly the UK and the US.

Saudi Arabia is an Islamic country, traditionally hierarchal, and has a unique gender-segregated society where gender is a structure of significance. Female education has developed exponentially since the first schools opened in 1960, with female enrolment exceeding male. Education has been key to Muslim women's understanding of their Islamic rights, yet their empowerment is constrained and enabled by state structures. The main role of Saudi women was to be a good wife and mother; employment was necessary for professions that served women and girls but was rarely a priority. However, increased opportunities and policies to integrate women into the workforce have been developing for more than a decade, through commitments to global initiatives for women's empowerment, culminating with the Saudi 2030 vision.

STEM education is currently manifested as the sciences and mathematics in Saudi public schools, but there are efforts to develop STEM education in schools despite the challenges presented by new pedagogies and teacher collaboration. Only the most academic students have the chance to pursue STEM education beyond grade 10. Gender stereotypes associated with subjects are not prevalent, as educational institutes are gender segregated and students are taught by same gender teachers. For Saudi women, a degree is important, for prestige and more recently to increase employability, as Feminization and Saudization policies aim to increase employment of Saudi citizens and reduce the dependency on foreign labour. However, there is no history of careers guidance in Saudi Arabian schools, instead families play a significant role in decision making and career guidance, where medicine is the most prestigious career.

The literature reviewed in this chapter highlights the scarcity of research regarding Saudi women in STEM education and careers. The current study provides an original contribution to knowledge by exploring the factors that influence Saudi girls' STEM aspirations and career choices. This has implications for policy and practice in Saudi Arabia.

The next chapter looks at the research design, starting with the research questions.

Chapter Three

Research Design

3.1. Introduction

The aim of this chapter is to demarcate the methodological approach of this study. The chapter will explain and justify the chosen methodology for conducting this study. This chapter begins by stating the research questions and then some of the major methodological approaches used in research will be briefly reviewed, followed by the preferred method for this study and the justification for using it. The research design and a detailed description of how it was conducted, the ethical approach, an outline of the data analysis, a reflection on the process in general, and its limitations are explained. Based on the critique of the relevant literature, the following key and secondary research questions were formulated to be addressed in this study:

1. Why are STEM-related education and careers important?

    a) What factors influence Saudi Arabian girls' decisions to study STEM subjects?

    b) What makes STEM subjects an appealing choice in Saudi Arabian Schools?

2. What kinds of STEM-related careers can be available to Saudi girls?

    a) What factors influence girls to follow careers in STEM and why?

    b) What is the importance of role models, voluntary work and work placements to motivate girls to enter careers in STEM and why?

The underrepresentation of women in STEM education and careers has been a topic of concern for many years, internationally, with most of the literature reviewed concentrating on secular societies where female education and employment are readily accepted, such as in the UK and USA. In some countries and societies women not working signifies wealth and their priority is taking care of the family. There is often a tendency to assume that the situation in those societies is stagnant and fluctuations are overlooked. Saudi Arabia, an Islamic country, has unique social structures; hierarchical and gender-segregated in the public sphere. The literature reviewed regarding Saudi Arabian women centred on concerns about women's rights in Saudi Arabia and highlighted a gap in studies concerning Saudi women in STEM education and careers.

Based on the knowledge gained from the literature critiqued in chapter two, this research aims to discover the rationale behind Saudi Arabian girls pursuing STEM education and careers. It explores the school and university education of Saudi girls and aims to uncover the interplay between structure and agency in Saudi for women realising their STEM aspirations in a conservative and religious society. An in-depth study was essential, as this study aims to add to the literature on Saudi Women and STEM education and careers in Saudi Arabia.

According to Basit (2010:1), "Educational research endeavours to examine educational phenomena to learn from them and to improve existing knowledge, policy and research". Researchers have differing views of the social world (Cohen *et al.*, 2011), either as a hard, external, objective reality or as the subjective experience of individuals in creating it (Burrell and Morgan, 2017). In each case, the search for understanding focuses on different issues and approaches (Burrell and Morgan, 2017), constructed on what constitutes valid knowledge about the social world, that is, ontology (Gunzenhauser and Gerstl-Pepin, 2006; Bryman, 2016), and the methodology that exposes the nature of reality, that is epistemology (Cohen *et al.*, 2011). The stance of the researcher on epistemological issues has implications for how social research is conducted (Bryman, 2016), but Crotty (1998) maintains that not too many people embark on a piece of social research with epistemology as the starting point. Typically, they start with a real-life issue that needs to be addressed, a problem that needs to be solved, or a question that needs to be answered.

3.1.1 Positionality

I have been a teacher of chemistry and general science in the UK and then in Saudi Arabia. Additionally, I have held senior management positions in schools in Saudi Arabia, where I have contributed to the enhancement of science education and the leadership skills for girls in the private sector. It was during conversations related to my experiences in Saudi Arabia, that people expressed their amazement that the narratives I conveyed depicted the active participation of Saudi girls in society. This almost always conflicted with both media representations and their own perceptions. I recognised that the views held about Saudi Arabian girls and women are not current as they inadvertently focussed on their rights and bore little reference to their educational achievements. As an educator, I was aware of the value placed on scientific subjects in Saudi Arabian society and I felt disappointed that the engagement of girls in STEM education was an area that had not been addressed, considering the global focus on STEM skills' shortages and the initiatives to engage girls in STEM educations. Thus, my research interest was triggered.

Researchers are part of the social world that they are researching, which itself is an interpreted world by the actors (Cohen *et al*., 2018). This study aims to determine the representation of women in STEM-related education fields and to depict Saudi Arabian women from a perspective that focuses on their education, using their own narratives. I am mindful of the biases and prejudices that I have from my educational experience in Saudi Arabia, however, in designing this research study I have dealt with them in a reflexive manner. Hopkins (2008) argues that, personal bias should be kept to a minimum because researcher inclination has an impact on the research:

> Research needs to be as objective as possible, and as any claim to objectivity or to a 'value-free' position is an illusion, personal biases have to be identified throughout the research process and strategies to minimise them have to be employed (Hopkins, 2008:203).

Accordingly, as my career in Saudi Arabia was focussed on the private sector institutions, the participants in this research will be drawn from a public university that I have had no previous contact with. As a former chemistry teacher, it is implicit that I have an enthusiasm for the subject, but participants will be informed that I am researching STEM education widely. Furthermore, as a natural scientist I am intuitively inclined towards positivist research, but, as this research is in education, selecting the most appropriate approach to address my research questions was considered carefully, as:

> The subject of the human world is a completely different enterprise from the natural worlds and thus must be known differently (Savin-Baden and Major, 2013:60).

It is important in this study to determine what types of STEM-related majors, students aspire to as the literature indicates that this has not been explored previously. Central to my study is the determination of how and why Saudi Arabian girls made their decisions, for which an interpretivist lens is essential. However, an initial survey gave me the necessary data to explore pertinent themes in more depth, thus enabling me to conduct a mixed methods study. I am conscious that research cannot be value-free as it is the researcher who interprets the data and presents the results. In this study, direct quotes from participants will be used to minimise researcher prejudice and bias. I will continuously practise reflexivity throughout the study as Basit (2010) suggests:

> They [researchers] need to ponder, as they embark on research, where they are coming from; what they want to investigate; when, where, and how they want to examine those phenomena; why this will be the best possible way of carrying out their research; and how they can ensure that their research is carried out in an ethical manner (Basit 2010:7).

Thus, I endeavour to ensure that this study is conducted rigorously and accurately. The findings of my study will be honest and truthful and my positionality as a mixed method researcher is clearly articulated.

The researchers' ontological and epistemological perspectives determine their choice of research paradigm, the basic belief system or world view that guides the investigation (Guba and Lincoln, 1994) and methodology, supported by ontological and epistemological notions.

The next section outlines the research paradigms that are relevant to this study.

3.2 Research Paradigms

As research paradigms look at a phenomenon from different perspectives, the researcher must have views about what knowledge or data are important and how they can be acquired. Every type of empirical study has its own implicit if not explicit research design that is influenced by paradigms.

> Paradigms are models, perspectives or conceptual frameworks that help us to organise our thoughts, beliefs, views and practices into a logical whole and consequently inform our research design (Basit 2010:14).

According to Cohen *et al.* (2011), each of the paradigms rests on different ontologies.

3.2.1 The Positivist Paradigm

The positivist paradigm supports objectivist ontology, has a clear theoretical focus for research, and follows the scientific method. The epistemological position of the positivist paradigm aims to explain how and why things happen through generating measurable data that can be statistically analysed and are stable across observers (Hammersley and Atkinson, 2007), using methods such as experiments, surveys and questionnaires or comparative analysis. Thus, positivism has been associated with quantitative research, where results need to be replicable for them to be considered valid and only verifiable statements have meaning (Paul, 2005). In other words, ideas only deserve their incorporation into knowledge if they can be put to the test of empirical experience (Gray, 2014). Hence, generalisation of findings is a characteristic of this paradigm.

3.2.2. The Interpretive paradigm

The Interpretive paradigm draws on a wide range of philosophical and sociological ideas that argue that the social world cannot be understood in terms of causal relationships. The main

ontological assumption is that social reality consists of social interactions where the meaning of actions and situations included in those interactions are interpreted. The epistemological assumptions of interpretivists are grounded on the view that knowledge is a product of everyday concepts they are based on, such as social meanings, intentions, motives, attitudes, and beliefs (Hammersley and Atkinson, 2007). For the researcher to understand the world from the participants' point of view, she/he must be actively engaged in their social world (Gray, 2014). This approach supports finding and documenting the different perspectives in the study and facilitates corroboration of evidence through triangulation.

Research paradigms and models offer researchers a comfort zone, to create a research program that blends approaches (Newby, 2014). The alignment of ontology, epistemology, and methodology are necessary in selecting the research paradigm. In this study, knowledge, views, attitudes, and actions are the important reality. It was important that this empirical study generate numeric data that describes the characteristics of the sample and their interaction with the variables, in addition to obtaining the perspective of participants through interviews. Thus, gathering 'thick descriptions' of their lived experiences (Geertz, 1973) was key to understanding how and why Saudi girls pursue STEM education and careers.

The next section outlines the research methodologies relevant to this study.

3.3 Research Methodologies

Educational research is often concerned with an issue at a significant scale, as well as the conditions that give rise to it. Quantitative approaches deal with the issues of scale, while qualitative approaches deal with the issue of experience.

One of the key differences between the two types of research methodologies (quantitative and qualitative) is the amount of pre-specified structure in the strategy used. Having identified a research issue or question, a research strategy and appropriate methodology for collecting information, or data, which will illuminate the problem, must be devised (Baker, 2000). Newby (2014) suggests that the research issue should guide the way in which it wants to be investigated.

3.3.1 Quantitative research

Quantitative research is an empirical research, generally used to test a hypothesis. It incorporates the practices and norms of the natural scientific model emphasizing quantification in the collection and analysis of data (Bryman, 2016). It allows for comparison and replication,

and reliability and validity are obtained objectively. At a descriptive level, quantitative research was useful in determining the extent to which students in this study engaged with or were influenced by the variables outlined in the questionnaire, such as the category of STEM fields students aspired towards, and how many were interested in each field. Such data lends itself to generalisations that could direct future educational planning and policies. One of the drawbacks of quantitative research is that it is not designed to discover deep, underlying meanings and explanations.

3.3.2 Qualitative research

Qualitative methodologies are associated with interpretative approaches to achieve a deep, understanding of a phenomenon. Hence, it focuses on emphasizing words rather than quantification in the collection and analysis of data (Bryman, 2016). Qualitative research relies on verbal and visual communication to answer questions, examining humans in their natural settings (Lichtman, 2013), and may include examining images, or artefacts (Punch and Oancea, 2014). Qualitative methodologies are strong in those areas that have been identified as potential weaknesses within the quantitative approach. However, Gray (2014:34) reminds us that in qualitative research, "generalizability is less important than understanding the real workings behind reality."

3.3.3 Mixed Methods approach

The differences in ontological and epistemological assumptions between positivism and interpretivism led the proponents of each paradigm to argue against a coexistence and combination of quantitative and qualitative methodologies (Denscombe, 2008). There has been a growing tendency to highlight similarities between quantitative and qualitative approaches (Denscombe, 2008) and for combining their use (Leech and Onwuegbuzie, 2009). According to Wellington (2015), the two methodologies complement each other; furthermore, he argues that educational research can yield both qualitative and quantitative data. Johnson *et al.* (2007) reasoned that philosophical variation should be appreciated in mixed methods research. Similarly, Newby (2014) propounds the view that mixed-methods brings together viewpoints that should not co-exist but agrees it can provide a practical way of solving problems. Gunzenhauser and Gerstl-Pepin (2006) note that researchers are increasingly using multiple theoretical perspectives rather than choosing a single worldview or paradigm, appreciating that the strength of both methods can provide a holistic understanding about social phenomena (Onwuegbuzie and Leech, 2005; Gunzenhauser and Gerstl-Pepin, 2006; Johnson *et al*., 2007). Furthermore, the successful practice of mixed methods studies,

combining qualitative and quantitative research in systematic reviews, has empirically disproved the incompatibility of the two methodologies (Scott and Briggs, 2009; Denzin and Lincoln, 2011).

In a sense, a mixed methods approach places importance on the issue being researched and the need to find answers to the questions, which then reduces the influence of philosophy (Crotty, 1998; Newby, 2014). In designing a research study, the motivations to combine different types of data should be transparent (Small, 2011) and beneficial. Mixed methods are useful, as combining information from complementary data tends to increase corroboration of data, render less bias, and lead to more accurate conclusions (Denscombe, 2008; Reams and Twale, 2008; Creswell, 2013; 2014). Furthermore, methodological pluralism also enables triangulation to be practised (Johnson *et al.*, 2007), which can increase the validity of the study. There has been much debate about how mixing of methods can be achieved, without specifying a rigid method, and Small (2011) advises that the extent of sequencing of the data collection, and the level of nesting of the multiple data sources, should be clear. Furthermore, Creswell (2013) suggests that the study begin with a broad survey to generalize results to a population and then focus, in a second phase, on detailed qualitative, open-ended interviews to collect detailed views from participants.

Much of the research literature reviewed regarding Saudi women was based on secondary data sources or quantitative studies; both strategies avoided close interactions or crossing cultural gender boundaries between researcher and respondents. In this study, I aimed to gather a broad range of quantitative data to establish the influence and impact of variables on student's decisions. But, most importantly, I was interested in finding out how Saudi Arabian girls make decisions to pursue STEM education and careers, by understanding their lived experiences from their personal narratives. Therefore, being a woman was important for the accomplishment of my qualitative research; participants would feel more comfortable sharing their experiences with another woman. Furthermore, as gender-segregation and cultural values in Saudi Arabia do not encourage non-essential communication between unrelated members of the opposite sex (van Geel, 2016), this research would not have been possible with a male researcher.

For the current study, a mixed-methods case study approach was preferred because of its potential to capture the participants' views on the same issues from different vantage points. Mixed-methods enables the researcher to validate data across data sets, using quantitative and qualitative methodologies, thereby increasing the accuracy of the research findings through triangulation. Quantitative data were first collected using questionnaires, before being

analysed. The data accrued from the quantitative analysis were used to address and inform the qualitative study, and forcibly helped the researcher to be more subjective. The quantitative data also provided a means of screening participants for the qualitative study. In-depth individual semi-structured interviews were used to collect qualitative data. The mixed-method approach produced both generalizable data and detailed narratives that illustrated a more complete picture of how Saudi girls' decisions to pursue STEM education and careers are enabled or constrained.

3.3.4 Case Study Approach

Case study is defined as "an empirical inquiry that investigates a contemporary phenomenon (the 'case') in depth and within its real-world context" (Yin, 2013:16); the research of real cases operating in real situations (Stake, 2013). Case studies begin in a world of action and contribute to it (Adelman *et al.*, 1976). According to Cohen *et al.* (2011:289): "Case studies can blend numerical and qualitative data and can be considered as a 'Prototypical instance of mixed methods," focusing on collecting up-to-date information. Different types of case studies have been identified by researchers.

Stake (2005) identifies three types of case study; intrinsic, to better understand a case; instrumental, to provide insight into an issue or to create a generalization; and multiple or collective, when several cases are studied jointly to investigate a phenomenon, population or general condition. These are comparable with the three type of case study identified by Yin (2009, 2013): exploratory, descriptive, and explanatory. Selecting the most appropriate case study research design depends on the context of the case. The four main case study designs identified by Yin (2009) are the single case, the embedded single case (multiple units) analysis, the multiple case, and the embedded multiple case. According to Yin (2013), multiple case study designs are mostly applicable to testing replications of a phenomena, whereas single case study designs are most beneficial when the researcher has an opportunity to observe and analyse a phenomenon which was previously not accessible to social science research, offering "an opportunity to research a case heretofore unresearched" (Cohen *et al.*, 2011:291).

In the case study approach, a large amount of data is usually collected; therefore, in reducing it, data will be selective, but may also be biased, personal and subjective (Nisbet and Watt, 1984). Therefore, researcher reflexivity is crucial in the case study process to address and minimize these problems. Fair representation of empirical data, and the use of multiple sources of evidence, is essential in case study research, according to Yin (2013).

Nevertheless, Cohen *et al*. (2011:294) emphasize that, “quality rather than quantity and significance rather than frequency is a hallmark of case study.” Single case studies do not lend themselves to replication (Harland, 2014); however, analytical generalizations of the findings may apply to other situations (Stake, 2013).

This study represents a unique case (see section 3.5.1), as it is the only one that explores the representation of Saudi women in STEM education and careers. The embedded single-case design (Yin, 2013) provided the opportunity to gather data from within and across the three participant groups. In this study, the foundation year students (FYS) are the single case, and the additional units of analysis are the perspectives of the third-year students (TYS) and faculty members (FM), offering sample triangulation. The findings of my study could be replicated in other Saudi universities and inform strategies for creating effective career support systems to guide students’ career decisions. However, Yin (2009:261) cautions that “Good case study investigators need to be adept at using different data collection methods.”

Popular data collection methods in case studies include, but are not limited to, focus groups, ethnographies, participant observations, interviews, documentary evidence, direct observations in the field, and surveys (Yin, 2009). For each unit of analysis, a quantitative survey and semi-structured interviews were chosen for data collection. The justification for my choice of methods is presented in the next section.

3.4 Research Methods

Research methods refer to the technical steps taken to accomplish the research. The decision on which instruments to use is based on the methodology chosen and fitness for purpose (Cohen *et al.*, 2011). As this study used a mixed methods case study approach, I chose two methods for data collection; questionnaires and interviews. In the first phase of the study, a broad quantitative study was conducted to produce reliable statistical data, and questionnaires were administered to the three groups of participants, FYS, TYS, and FM simultaneously; each questionnaire was worded differently, though all three dealt with the same issues. This was followed by a qualitative study, where a selection of participants from the same three groups were interviewed. All FYS were interviewed first to establish their perspectives on STEM education and careers for girls, and to understand how their STEM aspirations were formed. Second, all TYS were interviewed to understand how their aspirations to STEM majors began and if they been realised. Then, all FM were interviewed, to gain their perspectives on the STEM education provided in schools, and the impact on students’ aspirations for STEM careers. The processes of questionnaire data analysis and interview data analysis were

sequential (see fig 3.1). The sequential or two-phase design provided the flexibility to adapt the second stage according to the findings from the first phase (Feilzer, 2010). Furthermore, sample and methodological triangulation enabled phenomena to be examined from different perspectives, adding to the validity and reliability of the data.

3.4.1 Questionnaire Survey

Surveys offer an effective means of gathering structured data on multiple variables in a reasonable time using questionnaires. The researcher must remember that "the questionnaire will always be an intrusion in the life of the respondent" (Cohen *et al.,* 2011:377). Furthermore, Cohen *et al.* (2011:383) stress that "simply because the researcher is interested in and has a background in a topic is no guarantee that the respondents will be like-minded." In this study, the project information sheet provided some background to the study and aimed to attract the interest of the participants, since the topic was relevant to them.

Questionnaires require much less involvement on the researcher's part than some other methods, which means the researcher can spend more time on the setup and results. However, there is generally an expectation that survey respondents will comprehend the questions posed in the same way as the researcher (Feilzer, 2010). Bryman (2016) suggests that when questionnaires are distributed in a group setting, the participants can ask questions for clarification purposes. The absence of the researcher may lead to missing data (incomplete responses) (Bryman, 2016), because of the lack of clarity in questions. Before the questionnaires were distributed, the PMU administrator and I had discussed my research, and I found that she had enough knowledge to answer general queries, if needed. In this study, question clarity was checked by the PMU assessment unit and then tested during the pilot study.

There are many advantages to using questionnaires. First, they can provide a wide range of responses to the variables; second, they provide a means of gathering data in a timely manner which can then be statistically analysed with computer aided data analysis software; third, questionnaires minimize interviewer bias, guidance and cues that can affect the validity and reliability of the data collection (Bryman, 2015); fourth, they offer anonymity and confidentiality that may encourage participants to share their views. An additional and important advantage of using questionnaires was that they provided a strategy for screening participants for the second phase of the study; semi-structured interviews (Denscombe, 2008).

The questionnaires enabled the collection of data on what girls aspire to, what support they

have, how these aspirations developed, and an understanding of the impact of different structures on their decisions. In this study, the comparisons and generalizations within and across each of the three units of analysis provided empirical data that has the potential to influence policies within the wider context of STEM education and careers support in Saudi Arabian public schools.

3.4.2 Interviews

"If you want to know how people understand their world and their lives, why not talk to them?" (Kvale, 2008:1). Interviews are conversations with a purpose. By gathering data from participants on a topic being studied by the researcher (Lichtman, 2013), they present a means of exploring people's perceptions and constructions of reality (Punch, 2014).

There are three main types of interviews: structured, unstructured, and semi-structured. Each has its own criteria and the specific type chosen depends on the research purposes and questions. In structured interviews, the respondent is asked a series of closed questions, and all respondents are asked the same questions in the same order. The interviewer controls a structured interview (Wellington, 2015). These are like questionnaires whose highly structured nature may hinder the ability of respondents to provide illuminating information in a way that they would like (Gray, 2014).

Unstructured interviews are in-depth explorations of the interviewees' experiences and interpretations on their own terms (Punch and Oancea, 2014). Unstructured interviews depend heavily on the social and communication skills of the interviewer (Wellington, 2015) who must ensure that the interviewees maintain focus on the research issues (Basit, 2010). Semi-structured interviews are the most favoured type of interview in educational research. Patten (2016) suggests that although semi-structured personal interviews produce narrative material that can be time consuming to interpret, the merits of the method make it attractive.

There are several methods of conducting interviews; face to face, by telephone, or using electronic means, such as email, or software applications, that enable video-conferencing. More recently, technology has enabled participants to have face-to-face online interviews (Weller, 2017), but physical face-to-face interviews are still favoured. Furthermore, the former method presents problems, in situations where interviewees have limited access to the internet.

Telephone interviews are convenient; they have many of the same advantages of face-to-face interviews but tend to be shorter and lack the sensory stimulation of face-to-face interviews

(Cohen *et al.*, 2011). They require careful arrangements for timing and duration (Oppenheim, 1992), but are suitable when meeting face-to-face is difficult. They are usually based on the same types of questions as those in questionnaires, making them easier to tabulate (Patten, 2016), though questions requiring detailed answers are also asked and can be audio-recorded with the interviewees' permission. They can be used to collect sensitive data, or where, "some anonymity is requested" (Opdenakker, 2006:11). Another advantage is that participants could be reached at times more convenient to them (Cohen *et al.*, 2011) and no time is spent on travelling. The main disadvantage of telephone interviews is that body language cannot be used as a source of extra information, although social cues such as voice and intonation are still available (Opdenakker, 2006). In addition, respondents can simply "hang up on the caller" (Cohen *et al*., 2011:275).

Kvale (2008) points out that an interview inquiry includes pre-interview stages of thematic clarification of the research topic. In this study, individual interviews were essential to accurately attain a thorough understanding of each participants' experience and perceptions of STEM education and careers. It is recommended that an interview schedule be formulated in which the outline of topics and issues to be covered are specified (Kvale, 2008; Patten, 2016). This is likely to consist of core questions that would guide the interaction between the interviewer and the interviewee (Basit, 2010). Moreover, Corbin & Strauss (2015) suggest that having the list of topics is useful, especially if the participants are not overly talkative. The sequence of questions in the interview schedule is pre-determined by the researcher but, significantly, in a semi-structured interview, the researcher can follow up responses from interviewees by asking more probing questions to elaborate and gain more in-depth data on the issues.

In this study, I chose semi-structured interviews to gather qualitative data, which allowed me to ask questions that prompted in-depth responses, to substantiate responses from the questionnaire data and allow interviewees to inform my research with further insights that address the research questions. I felt it was necessary to allow interviewees to express their feelings and viewpoints, whilst maintaining a degree of control over the conduct of the interviews. Furthermore, as a lone researcher, I considered that the data analysis and interpretation of 35 semi-structured interviews was manageable and the data would enrich my research study. The interviews concentrated on specific topics, as outlined in the interview schedules (see Appendices VI-VIII).

At the start of my research study, I intended to carry out face-to-face interviews. However, it was difficult to arrange a suitable place to conduct them. With my understanding of cultural

norms in Saudi Arabia, I anticipated that participants would not be willing to meet an unfamiliar person in a private location, and meeting in a public location would not serve the purpose, therefore telephone interviews were the most suitable solution.

The selection of participants was one of the most crucial aspects of my research. The next section outlines how I selected my sample for each phase of this mixed-methods case study.

3.5 Sampling

According to Cohen *et al.* (2011), sampling is the method of picking out a small group to focus on, out of a larger group. This is necessary, as conducting research with large populations may be costly and time consuming. The population included all students who met the criteria to be included in the study (Gall *et al.*, 2010). The researcher almost always works with a sample (Gorard, 2003), where the term sample is used to indicate a smaller group, which is usually, though not always, a representative of a population (Oppenheim, 1992). Sampling has the advantage of making it easier to study the group in question. However, the sample size depends on the heterogeneity or homogeneity of the population and the sampling technique must be fit for the study. Generally, for quantitative research, the larger the sample the better, as it gives greater reliability (Cohen *et al.*, 2011), whereas samples are usually small in qualitative research for practical reasons such as costs and the time for generating and analysing data. In both cases, as Mason (2011) argues, the sample must provide access to enough data, with the right focus to enable the research questions to be addressed. It is important to note that a large sample does not guarantee representativeness, but this can be achieved through selecting an appropriate sampling strategy.

There are two main sampling strategies used in research: probability sampling and non-probability sampling. In probability sampling, every member of the wider population has an equal chance of being selected; choice is made on chance alone and there is less risk of bias in the sample (Creswell and Plano Clark, 2011). This type of sampling lends itself to generalizability and is most commonly used in quantitative research. In contrast, non-probability sampling is selective, whereby members of the wider population are deliberately excluded. This kind of sampling is favoured in qualitative research, in which researchers use their discretion, knowledge, or experience to choose the sample which best suits the purpose of the study (Basit, 2010). The sample therefore represents itself rather than the wider population.

3.5.1 The Case Study Sample

For this study, the most appropriate source to access my case study participants was a university. Selecting the university, the case, and the units of analysis that would best address my research questions required careful consideration to ensure reliability and validity of the data. The criteria for selecting a university were as follows: a public university in Saudi Arabia, with a female campus offering STEM subjects and majors, with a large enrolment of students in the foundation programs at the beginning of the academic year 2016/17. Furthermore, all participants for my study needed to be Saudi nationals. Since the universities also accept a limited number of non-Saudi students, the demographic data collected in the questionnaire was used to screen out non-Saudis from the study. The university I selected for this study will be referred to as 'Princess Miya University' (PMU), which is a pseudonym, to maintain its confidentiality.

PMU is one of the twenty-six public universities in Saudi Arabia (MoE, 2017), and is situated in a large city in Saudi Arabia. The government has made huge investments in the expansion of PMU campuses to meet the increasing demand for higher education and diversification of disciplines. PMU consists of a variety of faculties, including: arts, business, computer sciences dentistry, engineering, humanities, law, medicine, social sciences, statistics, and physical sciences at undergraduate level, and some of them at postgraduate level. High school graduates typically apply to PMU for entry onto a foundation year program either in the Administrative track or the Scientific track.

In this study, two sampling approaches were adopted: random sampling and purposive sampling. At the beginning of the foundation year, students usually have either a tentative or a firm idea of the major they would like to study. It was important in this research study to determine the STEM careers that students aspired towards when they joined PMU and how their decisions were formed. FYS were randomly sampled for the quantitative study, whilst both TYS and FM were purposively sampled. The approximate enrolment of female foundation year students at PMU in September 2016/17 was 5000. These included students aspiring to both STEM and non-STEM majors. To achieve a representative sample for the quantitative survey, 20% of all the FYS, (n=1000) were randomly sampled, with the aim of acquiring a sample of science track students (n=500).

By the third year of studies at PMU, students are pursing specific majors. The purpose of selecting TYS as a unit of analysis was to ascertain if their STEM aspirations on joining PMU were achieved and why they were inclined to choose their current majors. FM were selected

for two reasons: to gain insight into the variation of perspectives on the issues from an organizational level, and to facilitate triangulation of data obtained from FYS and TYS. Ten STEM faculties were identified in PMU: biology, biochemistry, chemistry, computer science, dentistry, engineering, mathematics, medicine, pharmacy, and physics. From each of these departments, three TYS and one FM were randomly selected for the quantitative study.

For the qualitative study, FYS were sampled as follows: All questionnaires were numbered during data analysis and collated based on the ten STEM faculties. Participants who were Saudi nationals and indicated a willingness to participate in a follow-up interview on their questionnaires were identified. The numbers for participants from each STEM group were generated using an online randomizer tool - https://www.randomizer.org/ - until 20 FYS were selected. This was somewhat constrained by the small number of students who were willing to be interviewed. The same strategy was repeated for TYS, but regarding FM, only five were willing to be interviewed. The final pool of interviewees consisted of FYS (n=20), TYS (n=10), and FM (n=5).

3.5.2 Survey participants

Most of the students in this study had attended public (state) schools (see Table 3.1), where math and science are taught in their mother tongue, Arabic. However, at PMU, the language of instruction in all STEM disciplines is English.

Table 3.1 Type and location of high school

School Type	**FYS* (n=312)**	**TYS (n=30)**
Public school (Government)	89.1%	70.6%
Private School (fee paying)	10.3%	29.4%
High School located in same town as PMU	92.0%	91.2%
High School not located in the same town as PMU	7.1%	8.8%

*O.6 % did not respond to the type of school and 1.0% did not indicate the location of their school.

The next section presents pertinent details about all the participants who took part in the qualitative study.

3.5.3 Interview participants

Tables 3.2 and 3.3 give an outline of the FYS and TYS STEM aspirations and the education level of key family members. All names have been replaced by pseudonyms to maintain anonymity.

Table 3.2 Foundation year interview participants

	Pseudonym	Preferred Major	Highest educational achievement		Siblings	
			Father	Mother	Older	Education level
1.	Lana	Biochemistry	BA	BA	None	-
2.	Abeer*	Chemistry	HS	Grade 11	None	-
3.	Hanouf**	Chemistry	HS	HS	5 sisters 2 brothers	BA/BSc
4.	Rana	Computer engineering	HS	Incomplete HS	2 sisters 2 brothers	BA/BSc
5.	Ghala	Computing	BSc	BSc	3 brothers	BSc /MBBS
6.	Talia	Dentistry	Talia doesn't know	BA	1 sister 2 brothers	Studying medicine HS
7.	Maram	Electrical engineering	MSc	BA	2 sisters	BA
8.	Sama	Engineering	BA	BA	None older	-
9.	Toleen	Engineering	PhD	BA	1 sister 2 brothers	BSc/MBBS
10.	Bushra	Engineering	BSc	BSc	3 brothers	BSc /2 HS
11.	Fatima	Industrial or Architectural Engineering	BA	2 years of university	1 sister	Studying biology
12.	Noor	Medicine	HS	Studying HS now	1 sister	Studying BA
13.	Dana	Medicine	HS	BSc	1 sister	Studying biology
14.	Juwana	Medicine	BA Business	Studying BA now	None	-
15.	Raneem	Medicine/Biology	HS	Completed HS with Raneem	2 sisters 2 brothers	MSc. BSc
16.	Sultana	Microbiology	BA	BA	None	-
17.	Shaden	Nutrition	BSc	HS	None	-
18.	Jumana	Pharmacy	MA Business	HS	1 brother	HS
19.	Lina	Physics	HS	HS	1 sister	BA
20.	Raghad	Practical science	HS	BA	1 sister 1 brother	Studying BSc

* first generation university ** 12 siblings in total

Table 3.3 Third year interview participants

	Pseudonym	Major	Highest educational achievement		Older Siblings	
			Father	Mother	Older	Educational level
1	Atheer	Electrical and Computer Engineering	HS	HS	**1 sister**	BSc Computer Science
2.	Nadia	Computer science now Information Systems	MSc	BA	None	
3.	Rawan	Computer Science	HS	HS	1 brother	BSc Engineering
4.	Malak	Statistics	BSc	BSc Mathematics	2 sisters	BSc Biology MBBS
5.	Gina	Statistics	BSc	BSc	None	
6.	Lama	Physics (originally practical sciences)	HS	Completed one year in university	1 sister	BSc
					1 Sister	HS (Married at 16)
					3 brothers	HS
7.	Yasmine	Biochemistry	HS	HS	1 brother	BA
8.	Waad	Microbiology	HS	BA	1 sister	BA
9.	Ahlam	Biology	HS	HS	2 sisters	MBBS
10	Dooa	Medicine	HS	MA Art	3 sisters	MA Business MSc Engineering BSc Pharmacy
					1 brother	Diploma

All faculty members were PhD holders, and Table 3.4 illustrates their demographics pertinent to this study.

Table 3.4 Faculty members' educational experience and role within PMU

	Pseudonym	Department	Role in PMU	Years in Higher education
1.	Nada	Biochemistry	Department Chair	11 years
2.	Maryam	Chemistry	Head of Department	24 years
3.	Nawf	Medical-Dentistry	Head of Department	23 years
4.	Amirah	Computer Science	Dept. Supervisor	9 years
5.	Nora	Math & Engineering	Mathematics Supervisor	4 years

3.5.4 Accessing the sample

Research design and access issues are integrally related (Feldman *et al.*, 2003), and gaining access to the research participants is key to fulfilling the research study. Cunliffe and Alcadipani (2016) advise that this can be a time-intensive process however, as it involves contacting and negotiating with many people before a door opens (Bell, 2014). In this study, participants were selected from PMU, a female only campus, yet, being female was insufficient to overcome the barriers that prevented my physical access to the PMU campus. Saudi Arabian government protocols demand strict scrutiny of non-Saudi visitors to government establishments. Every female-only establishment in Saudi Arabia is guarded by at least one security guard (*Haris*) stationed at the entrance, to prevent entry of men and only allow access to women who have gained permission from university management to enter.

The first stage in the process was to secure an appointment with the PMU gatekeeper. I was advised to send a text-message to inform her briefly about who I was and why I wanted to speak to her. This is common in Saudi Arabia, as women tend not to answer calls from unknown numbers. She responded, and we arranged a telephone call, during which she expressed interest in my study and agreed to a meeting. Feldman *et al.* (2003:6) advise that, "given the potential of these initial interviews, it is important that the researcher approach these encounters in a way that shows one to be reliable and trustworthy." Four months later, the meeting was arranged, but I maintained intermittent contact through text messages during the waiting period, to ensure that she remembered our conversation, as developing and nurturing relationships with key players in the field is crucial to both gaining and maintaining access (Feldman *et al.*, 2003).

Gatekeepers have more at stake than the researcher or participants; therefore, it was important to seek informed consent (Cohen *et al.*, 2011) from the heads of Institutions and participants themselves (Bell, 2014). During the initial meeting with the gatekeeper, I explained my research and we discussed the obstacles and possible benefits, which may be crucial to research findings, or the satisfaction in having contributed to the research and acquiring a greater personal understanding of the research area (Frankfort-Nachmias and Nachmias, 1992). We both agreed that this research would be an important contribution to the literature on Saudi Arabian women and that findings could have implications for STEM education and careers in Saudi Arabian schools and universities.

The gatekeeper explained that the first obstacle would be to obtain permission to have physical access to the participants within the campus. She expressed her concern that it would

be a lengthy process, often taking more than six months. However, she was keen to support the research. Since I required access to the participants studying at PMU, not the university per se, the gatekeeper offered to appoint an administrator within PMU that I could liaise with directly on all matters concerning my study. I found this suggestion agreeable. After our initial meeting, subsequent discussions with the gatekeeper were carried out through telephone calls and email correspondence.

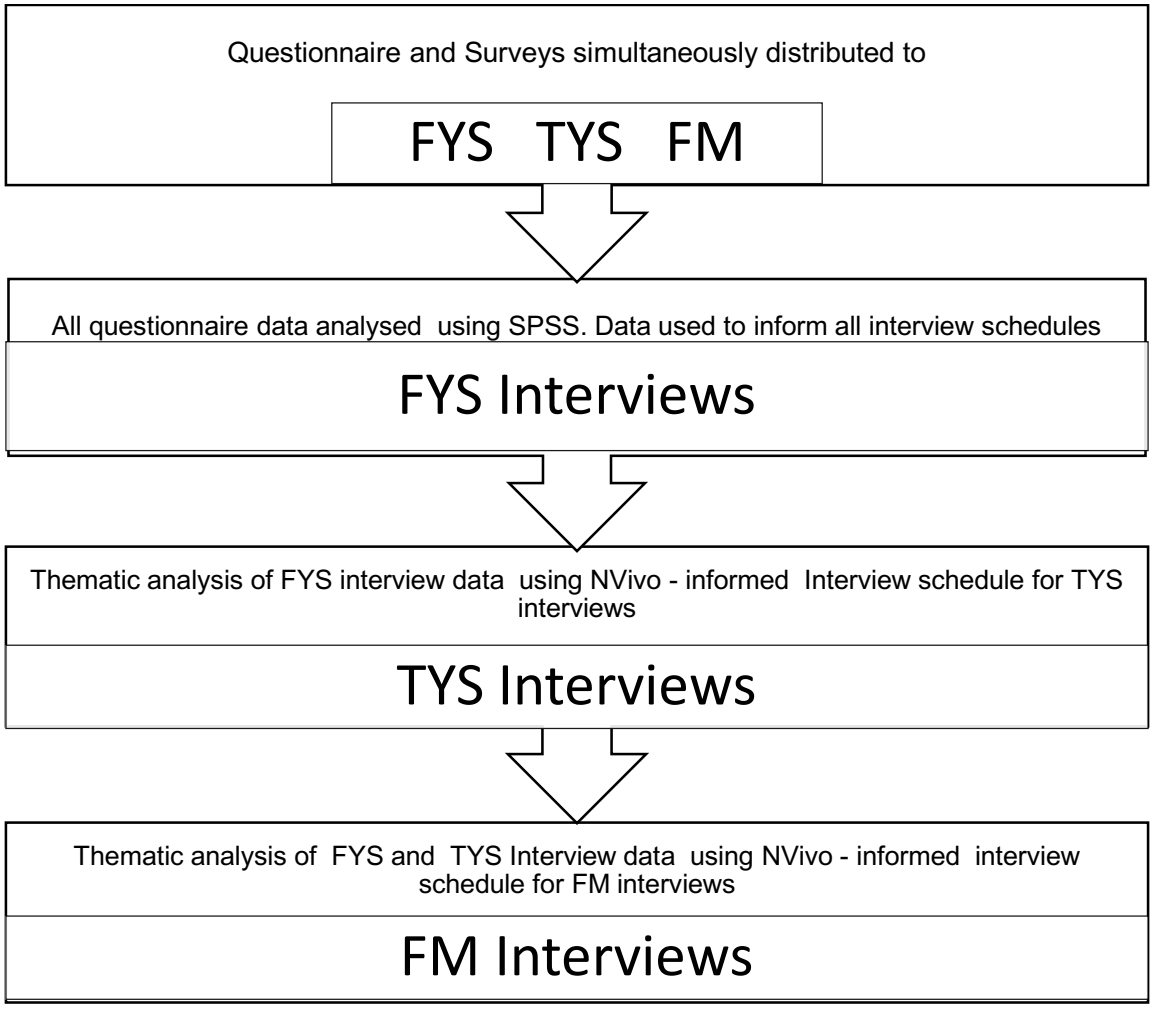
Following our meeting, I sent the requested documentation to the gatekeeper. This included a letter of intent from my PhD supervisor, my research study outline, the participant consent form, research instruments, and a letter from my employer confirming my right to reside in Saudi Arabia. My research instruments, three questionnaires, and three interview schedules were forwarded to the assessment unit at PMU for feedback based on their expertise in evaluating research instruments. The PMU administrator and I discussed my research in detail and she provided necessary data regarding STEM faculties and enrolment figures. Furthermore, she coordinated the introduction of my study to the target populations in PMU and distributed and collected the questionnaires on my behalf.

3.6 Research Instruments

Bryman (2016) indicates that the research design provides a framework for collecting and analysing data, and the decision to adopt a specific research design is determined based on the research aims. Research design is the logical sequence that connects the empirical data to a study's initial research questions and, ultimately, its conclusions (Yin, 2013). Cohen *et al.* (2011) emphasise the importance of planning the research early to identify the boundaries within which the research must operate. The preliminary research design for this study incorporated decisions about, which participants to include, the type of instruments most suitable for collecting data, and the length of time for data collection (Wiersma and Jurs, 2009). I chose a sequential design because, in exploratory research, new data can inform and influence procedures for subsequent phases. In addition, Creswell (2011:218) notes that, "In a sequential model, an analysis of quantitative data in the first phase can yield outlier cases. Follow-up qualitative interviews with these outlier cases can provide insights about why they diverged from the quantitative sample."

The initial data from the analysis of the questionnaires informed the development of the interview schedules for follow up interviews, as shown in fig 3.1.

Figure 3.1 Sequence of data collection



3.6.1 Devising the Questionnaires

There were many factors to contemplate when devising questionnaires for the present study. Cohen *et al.* (2011) highlight a range of practical implications, and emphasize that the questionnaire design, layout and structure should be planned carefully to assist data entry and subsequent analysis by computer. Furthermore, Palys & Atchison (2012:358) argue that many surveys "treat data collection and data analysis as two separate processes with no bridge between them." It was considered important in this study to design a simple user-friendly questionnaire that addressed the research questions and could be analysed easily.

There are two main types of questions: closed and open-ended. These questions can be presented as, Dichotomous, Multiple choice, Rating scales, Open-ended, Ranking, and Ratio data. The dichotomous question is a closed question, with a 'yes'/'no' response, and "it compels the respondent to give a clear, unequivocal response" (Cohen *et al*., 2011:383). Closed questions are quick and straightforward to complete and can present multiple responses from which the respondent may choose and enable comparisons within the sample (Oppenheim, 1992). While closed questions do not allow respondents to add any remarks, qualifications and explanations to the categories, Feilzer (2010) found that some respondents would scribble notes on the questionnaire. Open-ended questions, on the other hand, allow the respondents to elaborate on their responses. Nevertheless, these are time consuming, increase the possibility of nonresponse, and can introduce bias into the data. In this study, detailed responses were subsequently elicited during the semi-structured interviews.

For this study, the questionnaire was designed in a way that facilitated analysis using SPSS v24. I used a simple structure for the questionnaire with closed questions (Blaikie, 2009) in a matrix layout. The questionnaire was divided into three sections and the questions were organised in themes to enable the respondents to concentrate on one topic at a time (see table 3.5). Each questionnaire was two pages long, as the matrix layout reduced the space required for each question, with the questionnaires based on the research questions, the literature reviewed, and my prior experience in the Saudi Arabian education system. It was important to pilot the questionnaires, before the main study to ensure validity and reliability (see section 3.9.1.1.).

The FYS and TYS questionnaires used in this study were divided into three sections:

a) educational experience
b) career decisions
c) participant information

Table 3.5 Themes in each of the three questionnaires.

Main themes in the questionnaires	FYS	TYS	FM
Favourite subject(s) in school	√	√	
Difficult subject(s) in school	√	√	
Onset of STEM aspiration	√	√	
Decision to follow science track in grade 11	√	√	
High school information	√	√	
Career guidance and decisions	√	√	√
Intended major	√	√	√
Current major		√	√
Recommendations for high schools		√	√
Challenges to pursuing STEM career			√
Highest academic qualification			√
Willingness to be interviewed	√	√	√
Contact details	√	√	√

The research instruments were sent to the Centre for Academic Assessment (CAA) at PMU for review and feedback prior to the pilot study. Regarding the questionnaires, it was recommended by the CAA that most questions should be closed, as from their experience students rarely answered open-ended questions on questionnaires (Cohen *et al.*, 2011). Furthermore, it was advised that most information could be gathered from the interviews, and the questionnaire be limited to two pages, as students find long questionnaires time consuming and may fail to complete them. Another concern raised by the CAA was the English language skills of the FYS. The foundation year incorporates intensive English courses that enable students to reach a minimum standard before proceeding to the undergraduate majors. However, there were concerns that not all FYS would be able to understand all the questions if they were presented in English, particularly at the beginning of the academic year (Al-Asmari and Khan, 2014).

Questionnaires were due to be distributed in October 2016, but following the advice of the CAA, this was delayed until the FYS questionnaire was translated into Arabic. The translated questionnaire was checked for accuracy by two independent translators, as inaccurate translation of questions would result in erroneous results (Jenn, 2006). The other questionnaires were approved in English (Please see Appendices II, IV and VI).

3.6.2 Devising the interview schedule

"Qualitative interviewers have to work particularly hard on the structure and flow of the interview" (Mason, 2011:67). Preparing an interview schedule, according to Cohen *et al.* (2011), means translating the research objectives into the questions. The types of questions and statements used can be categorized, for example, as descriptive, experience, knowledge, or demographic, but all need to be related to the research questions. The fundamental objective in developing the interview schedule in this study was to gain a deeper understanding of the participants' perceptions expressed on the themes in the questionnaires.

Three interview schedules were formulated, for FYS it included 34 questions and TYS had 35 questions (one question was added relating to changes to their initial aspirations (qu7)). The interview schedules were divided into six sections to guide the sequencing of questions during the interview (Please see Appendix VII and VIII). The interview schedule for the FM consisted of 31 questions divided into four sections (Appendix IX). The interviews were semi-structured, which allowed flexibility in exploring themes that surfaced during the interviews. Open-ended questions supply a frame of reference for respondents' answers but put minimum restraint on their answers and expressions Kerlinger (1970, cited in Cohen *et al.,* 2011). The most important benefit of open-ended questions is that they allow the researcher to find out more than anticipated, as interviewees can share unexpected perspectives, motivations, and concerns (Punch and Oancea, 2014).

I conducted 35 semi-structured telephone interviews. All interviews were conducted in English, and audio recorded on an independent voice recorder for ease of transcribing and revisiting the interview. Two interviewees did not give their consent for their interviews to be audio-record, as they felt uncomfortable with their voices being recorded, therefore, 33 interviews were audio-recorded. Interviews that are audio recorded and transcribed verbatim provide an in-depth perception of the interviewees that can never be captured by note-taking during interviews (Basit, 2010).

3.7 Validity and Reliability

Validity signifies that the research measures or describes the phenomena that it set out to measure or describe (Basit, 2010). At every stage of the research process, there are threats to validity. It is the role of the researcher to ensure that concepts can be identified and measured in the way that they have claimed, and inconsistencies must be addressed to minimise them. Since this study employed a mixed-methods approach, steps were taken to ensure the validity and reliability of both the quantitative and qualitative aspects of the research.

Reliability in quantitative research is achieved through consistency and replicability over time, instruments, and participants (Basit, 2010). The reliability of quantitative instruments can be determined statistically, by tests that measure if the items in the instruments are testing the same phenomenon. In this study, Cronbach's alpha (**α**) was used to assess the internal consistency of the questionnaire; 24 scale items were included in the FYS questionnaire in three sections: i) School experience - I decided to follow the science path in grade 11 (8 items), ii) Career decisions – My school (7 items) and iii) Career decisions - Strategies that helped me decide on my college major (9 items). Cronbach's alpha showed the 24 scale items in the questionnaire reach acceptable reliability, $\alpha = 0.74$. Most items appeared to be worthy of retention, resulting in a decrease in the alpha if deleted. The TYS and FM samples were too small for reliability analysis of their questionnaires to be conducted.

In qualitative research, validity and reliability are determined using non-standardized methods, as it is improbable in qualitative research to replicate results using similar participants, settings and methods (Basit, 2010). Validity of qualitative data can be expressed as trustworthiness (Butler-Kisber, 2010), honesty, depth, richness, and meaningfulness to the participants (Cohen *et al.*, 2011). Heale and Twycross (2015) argue that consideration must be given to both the results of the study and the rigour of the research. Rigour refers to the extent to which the researchers worked to enhance the quality of the studies. The methodology and the principles of the current research were robust, and the research was designed carefully, as inappropriate methods can invalidate the findings. Validity and reliability can be achieved by formulating a clear research framework in case studies (Gibbert and Ruigrok, 2010) and comparing empirically observed patterns with predicted, or previously identified, patterns (Denzin and Lincoln, 2011). Adelman *et al.* (1976) advise that triangulation is a useful technique for case study, whilst Yin (2009) suggests maintaining a chain of evidence by tracking every step of the process to demonstrate reliability and validity.

For this study, validity and reliability of the data were verified through sample and methodical triangulation. Methodological triangulation is most frequently used in education, possibly has the most to offer (Cohen *et al*., 2011), and is used to obtain complementary data on the same topic (Punch and Oancea, 2014). Data were collected using two methods, a survey questionnaire and semi-structured interviews, from three groups of participants: FYS, TYS, and FM. The sequential design of my study aided integration of the methods and the data obtained in each phase was guided by the analysis of data in the preceding phases (see fig 3.1). The audio recordings of the interviews were transcribed soon after the interviews and any additional notes taken during the interviews were included in the analysis, as appropriate. During the analysis and interpretation stage, audio recordings and transcripts were checked before quoting from the data. In addition to uncovering findings that mutually reinforce each other, different viewpoints also surfaced, including outliers which differ from the majority but were included if relevant to this study (Trend, 1978).

The questionnaire items and interview schedules were reviewed for readability, clarity, and comprehensiveness at the CAA in PMU, and amendments were made. A pilot study was conducted on a sample selected from the same groups that represented the main sample, to check that the instruments were valid. The data collected was not included in the main study. As far as the researcher is aware, honest responses were given in questionnaires and interviews since participants were volunteers who indicated that they were genuinely interested in contributing to the study. The data obtained from the three groups was triangulated to enhance the validity and reliability of the research and was analysed and written up meticulously. As Basit (2010) points out, it is important for the researcher to illustrate to the audience that the entire research procedure has been conducted honestly and that data has not been falsified.

The next section discusses the ethical approach employed in this study.

3.8 Ethics

All educational researchers have a duty to act ethically to protect the integrity and reputation of their research by ensuring that they conduct it to the highest standards. Ethics is the appropriateness of your behaviour in relation to the rights of those who become the subject of your work or who are affected by it (Saunders *et al*., 2009). It is imperative that research is transparent in its value, goal, the audience, and how it is intended to relate to policy or practice (Cunliffe and Alcadipani, 2016), and is conducted in accordance with rules, laws, and codes of practice (Stutchbury and Fox, 2009).

In this study, I followed the professional code of practice highlighted by the British Educational Research Association (BERA) and adhered to the ethical guidelines for educational research (BERA, 2018). Ethical considerations were essential at all stages of the study; from planning the study through to reporting the findings. The main principles considered were respect for the autonomy and dignity of persons, maximising benefit, and minimising harm by avoiding reputational damage to the individuals and institutions involved. However, ethical decision-making is an actively deliberative, ongoing and iterative process of assessing and reassessing the situation and issues as they arise (BERA, 2018), which I carried out throughout the research.

Ethical dilemmas also arise in relation to protecting the integrity of the research, the ability to be transparent about the data collection process, and maintaining the anonymity of the organization and participants, that is, how to translate the research experience into meaningful knowledge without compromising the research, researcher, and organizational participants (Cunliffe and Alcadipani, 2016). Wide consultation is recommended to identify relevant ethical issues, including listening to those in the research context/site(s), stakeholders, and sponsors (BERA, 2018). In many Western societies, adults are mostly free to make their own decisions, but in non-Western cultures, that authority may rest with leaders of the family or community (Hammersley and Traianou, 2012). In this study, individual consent from participants was not likely to impose any cultural dilemmas, however, accessing the participants needed to be negotiated first.

After drafting the initial research plan, it was discussed with the PMU gatekeeper, who provided valuable advice that addressed the ethical issues pertinent to the university and prospective participants. An assurance of anonymity and confidentiality was essential due to societal concerns and this was achieved, as outlined below. Once the gatekeeper had given her consent (see appendix X), participants understood the importance of the research study, were supportive of the study and participated voluntarily. This study focused on minimally sensitive topics, with negligible intrusion or disruption to PMU, and involved participants who were all adults. For example, collecting data regarding household income was avoided, as this is regarded as private data and typically held by the head of the household only.

3.8.1 Responsibility to participants

Each participant in this study was given an information sheet, along with the questionnaire, on which they were informed about the study and of their right to withdraw from the research study, at any time without prejudice, up to the point that the data had been aggregated and or

analysed (BERA, 2018). The completion and submission of the questionnaire was accepted as consent for the quantitative study. Frankfort-Nachmias and Nachmias (1992) underline the need for confidentiality of participants' identities, and that any violations of this should be made with the agreement of the participants. For the qualitative study, consent was gained if participants provided contact details on the questionnaire in the form of their email address and telephone number. During my initial telephone calls to arrange the interview, some faculty members expressed concerns about being identified, fearing job loss from comments made during the interview (Cohen *et al.*, 2011); only six consented to participate in the interviews. After completing the questionnaire and agreeing to the interview, one faculty member later withdrew her consent; she was concerned about expressing her views to a researcher who was unknown to her.

To maintain confidentiality, the names of the participants and the university were anonymized using pseudonyms. The completed questionnaires were given ID numbers, and each interview transcript was labelled with the same ID number as the respective participant's questionnaire, before being uploaded into the NVivo platform. All electronic data were saved in password protected folders. Hard copies of questionnaires, transcripts, and the audio recordings were stored in a locked filing cabinet.

Conducting telephone interviews supported my intent to minimise the introduction of potential bias. Face-to-face interviews tend to be longer than telephone interviews, and bias can occur if interviewees change their behaviour according to their interpretation of body language. During interviews, care was taken to avoid mentioning my affiliation with the sciences, so that I could establish stimulating conversations focused solely on their experiences. Throughout each interview, I treated interviewees in a respectful manner, and I was honest and transparent about the nature of the research. At the end of each interview, I thanked participants for their contribution to my study and gave them a few words of encouragement for their future pursuits.

3.8.2 Reporting findings

Data analysis was conducted rigorously, and analysis of data from the quantitative and qualitative research have been clearly reported in this study. Lester (1999:3) points out: "There is an ethical issue about misrepresenting, distorting or deleting findings which have been provided in good faith by participants." Despite the need for data reduction for the description and interpretation of the phenomenon under study (Wiersma and Jurs, 2009), the essence of the study was maintained. Also, I repeatedly checked the audio recordings during transcription

to ensured accuracy, as several direct quotes from participants were included in the final report to illustrate their perspectives. Methodological triangulation and sample triangulation led to the formation of themes crucial to answering the research questions. My commitment to completing the study and publishing the findings were discussed with the gatekeeper at the initial interview (Corbin and Strauss, 2015), who supported the study based on its potential benefits for girls in Saudi Arabia. This study was conducted ethically, from planning, through to conducting and reporting.

3.9 Pilot Study

A pilot study can reduce the risk of defining and selecting the wrong case. The pilot case can specifically tighten the link between research questions and the likely availability of evidence (Yin, 2009). Once constructed it was important to test the questionnaires, and interview schedules. “Sometimes the main study is too ambitious … A pilot study will give us a taster of what will be involved in the real study and help us to scale down our objectives” (Basit, 2010:72). The pilot study was conducted to determine the feasibility of the study by focusing on the participants’ experience of research instruments regarding language, completion time, clarity of questions and identification of potential practical problems. It was an opportunity to obtain preliminary data and practise the data-analysis methods on a smaller scale. Although the benefits of conducting a pilot study prior to the main research study are well documented (Van Teijlingen and Hundley, 2002; Cohen *et al.*, 2011), the suitable sample size for a pilot study is not clearly stated (Hertzog, 2008). Such guidance on sample size is quite diverse, from statistical determination of sample size (Johanson and Brooks, 2010), to a more general small number of individuals (Tait and Voepel-Lewis, 2015).

3.9.1 Procedure

The pilot research study was conducted with the thirteen participants, five FYS, five TYS, and three FM who volunteered to participate in the study. The three groups were from the target populations PMU. After the pilot study, any modifications to the research instruments or research design were made before the main research study was undertaken (see Table 3.6). NVivo 11 was used for thematic coding of textual data from the interviews. The data collected from the pilot study was not included in the final research as Van Teijlingen and Hundley (2002:2) point out, “If there were problems with the research tool and modifications had to be made in the light of the findings from the pilot study, data could be flawed or inaccurate.”

3.9.1.1 Piloting the questionnaire

In the first stage, three questionnaires were piloted, one in Arabic for FYS and two in English, one for TYS and another for FM. All Information sheets and questionnaires were distributed and collected by the appointed PMU administrator upon completion. The data gathered from the FYS questionnaire was translated into English before analysis of the pilot study data commenced. The translated transcripts were back translated into Arabic to ensure accuracy. As the questions were closed, the translation required was minimal. The data collected from the questionnaires were analysed using IBM SPSS v24. The data generated from the analysis were used to guide the development of the interview schedule for the pilot study.

3.9.1.2 Piloting the interview schedule

The second stage of the study was to pilot the semi-structured interview schedules. Each interview took place after an initial telephone call was made to arrange the appointment. Semi-structured telephonic interviews were conducted in English with FYS (2), TYS (2), and FM (1). I sought the permission of the participants to audio record interviews, which were transcribed immediately after each interview. The time taken for the interviews was noted as a guide for the main study; it was between 20 and 40 minutes. During the pilot study, it became apparent that the two TYSs interviewed were not Saudi nationals, thus a third interview was then conducted with the only Saudi TYS who had volunteered to be interviewed from the sample of five.

3.9.1.3 Revisions to research instruments

Revisions made to the research instruments are outlined in Table 3.6. In the pilot study, respondents made some notes on the questionnaire, for example, regarding answering Likert scale–type questions they attempted to clarify the responses, as this type of question reveals little about a respondent's reasoning (Feilzer, 2010). Clearly, this was subjective and presented a degree of ambiguity that would introduce problems during the analysis of the responses, so the Likert scale-style questions were replaced with dichotomous questions.

Table 3.6 Revision to research instruments

Research Instrument	Items added	Items removed
Questionnaire	Dichotomous questions	Likert-type questions
	Nationality – to screen for Saudi nationals	
	Printing contact details clearly	
Interview schedule	Question related to how Saudi women inspired students to pursue STEM majors.	
	Question related to STEM encouragement for girls and boys	
	Questions related to the impact of siblings and extended family on career choices	
	Rephrasing of question 10	
	One question related to their perceived role in achieving the 2030 Vision	

Use of the 5-point Likert scale in question 10 was less beneficial than anticipated, as some participants felt they needed specific criteria to choose between the options and wrote explanations on the questionnaire to clarify their responses. Based on these observations, I adjusted the possible responses to yes, no, and not sure. Space for contact details to be printed clearly was included in the amended questionnaire. Some questions in the interview schedule were rephrased using simplified English for clarity and a question related to the 2030 vision was added as these reflected changes taking place in Saudi Arabia at the time of my study. All modifications were made before the questionnaire was used in the main study.

3.10 Data Collection for the Main Study

The time available to collect data was a limiting factor, it was essential that FYS were in the foundation year throughout the study. The academic year in 2016/17 in Saudi Arabia began in mid-September and ended in May 2017. The data in this study was collected in two phases: the first involved the questionnaire survey and the second involved the semi-structured interviews.

3.10.1 The Questionnaire Survey

The first phase was conducted between November and December 2016. The PMU administrator was given all the information sheets and questionnaires for distribution to the participants. Before they were distributed, she explained my study and reiterated that participation was voluntary. For FYS, questionnaires were randomly distributed at the beginning of sessions where both STEM and non-STEM students were present. During the foundation year, students have some common core courses and the science faculty houses colleges for some non-STEM disciplines for example Law and Psychology. The questionnaires were distributed to 1000 FYS and 887 questionnaires were collected. Of those completed 312 were aspiring to STEM majors, 435 were aspiring to non-STEM majors (which was stored for future analysis) and 140 were lacking enough data to be beneficial to this study. The aim was to gain a representative sample of FYS students aspiring to STEM majors by random sampling of FYS. The TYS and FM information sheet and questionnaires were distributed to three TYS and one FM from each of the specified STEM faculties (biology, biochemistry, chemistry, computer science, dentistry, engineering, mathematics, medicine, pharmacy and physics), thus a total of 30 TYS and 10 FM participated in the questionnaire survey.

3.10.2 The Interviews

The second phase of the current study was the qualitative data collection. This empirical study was designed to understand the perspectives of the participants about their past and present educational experience and potential careers. After selecting the sample for the qualitative research, each participant was contacted by telephone to arrange a suitable time for the interview. In cases where there was no response, I sent a text message to introduce myself and then followed it up with a telephone call. I explained the purpose of the interview, the benefits of the research and ensured that participants were comfortable with proceeding. As I anticipated that audio recording of the interviews may not be culturally favourable for some participants, I informed them that I intended to audio record the interviews, for my use only. Most were agreeable, but where two participants objected, only notes were taken during the interview, to respect their rights.

I conducted individual semi-structured, telephone interviews with FYS (20), TYS (10), and FM (5). It was important to complete interviews sequentially beginning with FYS, then TYS and finally FM, as analysis of the data gathered from one sample led to new questions that could be posed to the remaining participant groups. All interviews were conducted in English, with

use of Arabic by participants for expressing ideas where necessary, as CAA agreed that FYS were capable of conversing in English. Since I have a fair understanding of the Arabic language, where interviewees spoke intermittently in Arabic, I transcribed the recordings. The transcriptions were subsequently checked by two native Arabic speakers to confirm that the interviewee had understood the question and that I had interpreted and responded correctly. This was found to be correct in each case.

The consent of participants to audio record the interviews was requested at the start of each interview. Two participants objected, and notes were taken during their interviews and typed later. I encouraged the interviewees to elaborate on their responses as much as they wanted, to gain a more comprehensive narrative of their perspectives. Lester (1999) advises that building a rapport with the participants helps to generate meaningful and useful data, but Bryman (2012) warns that too much rapport can lead to longer interviews, whilst lack of rapport may cause participants to terminate the interview. The interviews were conducted amicably; interviewees were made to feel at ease and appreciated, as Bell (1991) reminds us that people who agree to help are doing the researcher a favour. After each interview, I had a short conversation with interviewees, thanking each one for their participation and answering any questions they posed.

3.11 Data Analysis

3.11.1 Quantitative data analysis

Quantitative methodology aims to reveal patterns and generalizations in the data obtained, which can be determined using statistics. Descriptive statistics were the main statistical approach used in the analysis of the data in this study. The data collected was analysed using IBM Statistics package SPSS v24. Punch and Oancea (2014) suggest that an initial descriptive analysis keeps the researcher close to the data and enables an understanding of the distribution of each variable across the survey respondents by providing summary information about the data. In this study, the quantitative data were mainly categorical and nominal. A nominal measurement scale is used for mutually exclusive and exhaustive categories; the variable under measurement can take only one value out of the given options (Kalla, 2011), which is appropriate for descriptive statistical analysis such as frequencies.

The responses from the FYS questionnaire were translated into English and checked for accuracy before analysis. Since the questions were all closed, the translation was minimal, but participants wrote notes where they felt it was necessary to clarify a response; for example,

two students mentioned that their grandparents were deceased, hence, they could not discuss career options with them. The questionnaires were given ID numbers, the variables were named, and the data were coded (Greasley, 2007). The nominal data were assigned numerical values: 0 for yes, 1 for no, and 2 for not sure. A different set of codes were used for categorical questions; for example, the grade ranges when aspirations began were given numbers from 0 to 5. Initially, all the codes were recorded on a copy of the questionnaire, then a codebook was produced as a useful reference point. Frequencies of responses were generated for each question. The main aims of this study were to determine the onset of students STEM aspirations and to understand how students made decisions about their STEM career paths, from joining the science track to selecting a major. As FYS share similar characteristics to students in other Saudi public universities, further studies could determine the generalisability of these findings.

3.11.2 Qualitative data analysis

Data analysis in qualitative research is a process of categorization, description, and synthesis, and the researcher needs to be transparent about how data is analysed so that the analysis is trustworthy (Nowell *et al.*, 2017). Qualitative data interpretation is achieved through the process of coding, breaking down data to make sense of them, and reconstructing them to consider similarities and differences (Basit, 2010). There are multiple ways of interpreting the truth, each having different criteria; for example, Denzin and Lincoln (2011) consider the interpretive practice of making sense of one's findings as both artistic and political. It also enables divergent explanations and different viewpoints to arise. For this reason, Trend (1978) recommends postponing the immediate rejection of data that is at odds with the majority viewpoint.

In designing this research study, alignment between the type of data to be collected, the preparation of the research instruments and the method(s) of data analysis were contemplated. I chose a thematic analysis to identify, analyse, and report patterns within the data (Braun and Clarke, 2006) and used qualitative data analysis software (QDAS), NVivo 11, to facilitate both data management and data analysis processes (Bazeley and Jackson, 2013). All textual data were collated in one platform for analysis, which eased the task of identifying common themes across participants in different data sets (Ishak and Bakar, 2012).

Analysis of the qualitative data was guided by the six phases of thematic analysis: familiarisation with data; generating initial codes; searching for themes; reviewing themes, defining and naming themes; then producing the research report (Braun and Clarke, 2006).

Braun and Clarke (2006) argue that, in thematic analysis, themes do not emerge, as this indicates a passive account of the process of analysis. Themes are extracted or constructed (Saldaña, 2015) as the researcher makes sense of the data (Tesch, 2013; Miles *et al.*, 2014). Themes were data driven, largely because of the lack of previous research about Saudi women in the context of this study.

Qualitative data were gathered from 35 semi-structured interviews. After each interview, the audio recording was transcribed almost immediately to ensure accuracy, in the event of spoken words not being clear or poor recording (Basit, 2010). Transcribing is labour intensive and time consuming (Palys and Atchison, 2012). Each recording was revisited several times to increase the accuracy and quality of the transcript, ensuring that an account of all verbal utterances was documented (Braun and Clarke, 2006). During the interviews and transcription, initial areas of interest and recurring ideas were documented (Lincoln and Guba, 1985). Text was identified from the quantitative surveys that could be coded, and these were added to the transcripts and later coded. Qualitative analysis is a recursive process (Braun and Clark, 2012); each data set of transcripts was reread before importing them into NVivo 11 for coding. By the end of this process, I was well acquainted with the perspectives of the interviewees.

Codes identify a feature of the data that appears interesting to the analyst and can be assessed in a meaningful way. The initial categories were derived from the data during the process of data collection and by examining the interview transcripts (Bazeley and Jackson, 2013). Each transcript was searched line by line to ascertain the meanings of statements and how they relate to the themes, as themes express the meaning of the segments the researcher has bounded (Tesch, 2013). This method of searching was used to avoid excluding any important data and to identify extracts that could be used as quotes in the thesis. Cohen *et al.* (2011) advise that selection of data should not only focus on representativeness but also include unrepresentative yet critical incidents or events that are crucial to the understanding of the case.

Text from the transcripts was coded to themes and sub-themes were created as additional themes were discovered or constructed. Thereafter, all the themes were reviewed, some were retained, and others were merged creating a hierarchical order (Basit, 2003). Initially, 25 codes were identified: Dreams, interest in STEM, curriculum, high school experience, pedagogy, teachers, careers advice, school support, university experience, barriers, cultural expectation, discouragement, peer advice, STEM encouragement for boys and girls, family support, family educational capital, gender segregation, GPA, religion, role models, employability, marriage

and work, voluntary work, work experience, 2030 Vision. Following a thorough review of the coded extracts, the initial 25 codes were consolidated into four themes: Personal aspirations, family encouragement, high school experience, and cultural trends.

The descriptive data generated from the questionnaires, the interview data and textual questionnaire data for each participant were integrated in the thematic analysis. During the data analysis, I reviewed the emerging literature regarding social and economic changes within Saudi Arabia and STEM education in general. This was done to ensure that the data collected and any relevant changes that could have implications for my study would be reflected in my research.

3.12 Conclusion

This chapter is an exposition and justification of the stages and development of my research. It includes the research questions, my philosophical stance, the research methodology, and methods of data collection and analysis. It demonstrates the strategies used to ensure that the research was conducted ethically, and the findings are valid and reliable. This research was exploratory, using a sequential mixed method case study design to discover the reality from participant's perspectives.

The next two chapters, chapters 4 and 5, will discuss in detail the findings and analysis of the data collected in this study.

Chapter 4

FINDINGS AND ANALYSIS 1

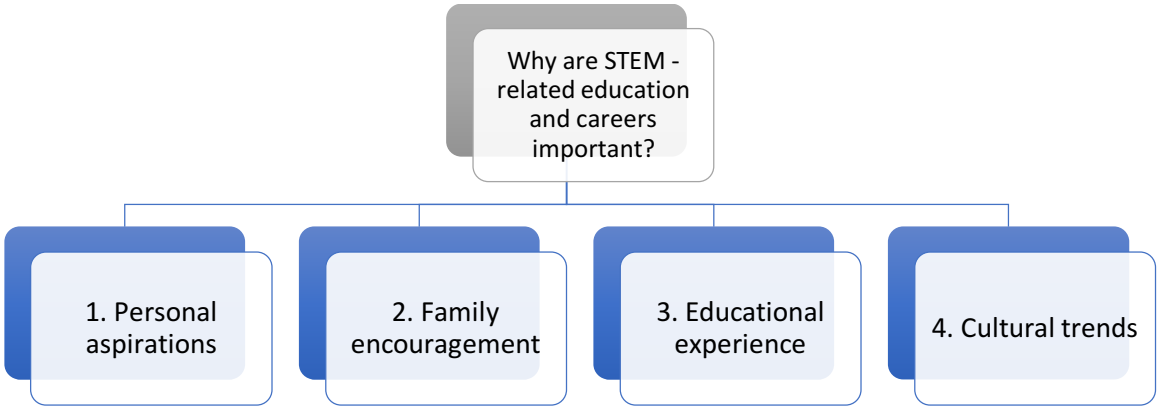
4.1 Introduction

This chapter discusses the findings and analysis of the quantitative data gathered from foundation year students (FYS), third year STEM students (TYS), and STEM faculty members (FM) at Princess Miya University (PMU). It also analyses the qualitative data from semi-structured interviews with a purposive sample from each of the three groups. This chapter relates to my first research question, (Why are STEM-related education and careers important?). Furthermore, it analyses the data related to my two sub-questions (What factors influence Saudi Arabian girl's decisions to study STEM subjects? and What makes STEM subjects an appealing choice in Saudi Arabian Schools?). Throughout this chapter, there is a focus on understanding the key influences on FYS' decision to study STEM subjects in high school and to pursue STEM majors in PMU. The data from all sources is analysed thematically and side by side. It captures past and present aspirations of the FYS and draws comparison with those of the TYS, thereby identifying any similarities and differences in their experiences. Furthermore, data gathered from FMs provides invaluable perspectives on Saudi society, its bearing on female education over time, and the impact of the Saudi 2030 Vision on the STEM career prospects for Saudi women.

4.2. Factors influencing Saudi Arabian girls' decisions to study STEM subjects

When quantitative data are presented in isolation, they can have the tendency to provide a limited interpretation or exploration of meaning (McKim, 2017). In this study, the survey examines the frequency of variables to give an overall illustration of the sample and empirical associations between variables, whilst the interview data explains the outcomes (Smith *et al.*, 2016). The data analysis in this chapter has been divided into four sections, based on the four main themes that emerged from the survey and semi-structured interviews: Personal aspirations, Family encouragement, Educational experience, and Cultural trends. Quotations from interviews have been included in this chapter and the next chapter with the interviewee's pseudonym, followed by the group that she belongs to FYS, TYS, or FM.

Figure 4.1 Themes



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Students in Saudi Arabian public high schools choose a scientific or literary track of studies for their final two years in school (grades 11 and 12), leading to graduation. Students with a Grade Point Average (GPA) above 60% in all subjects pursue either track, whilst those with lower GPA's must follow the literary track, as mentioned in chapter 1. The latter would prevent any future access to STEM education (Adamuti-Trache and Andres, 2008) in Saudi Arabia. It is therefore important that Saudi Arabian student's interest in future STEM education is realised prior to grade 10. Early aspiration was one of the elements that influenced students in this study to favour the science track.

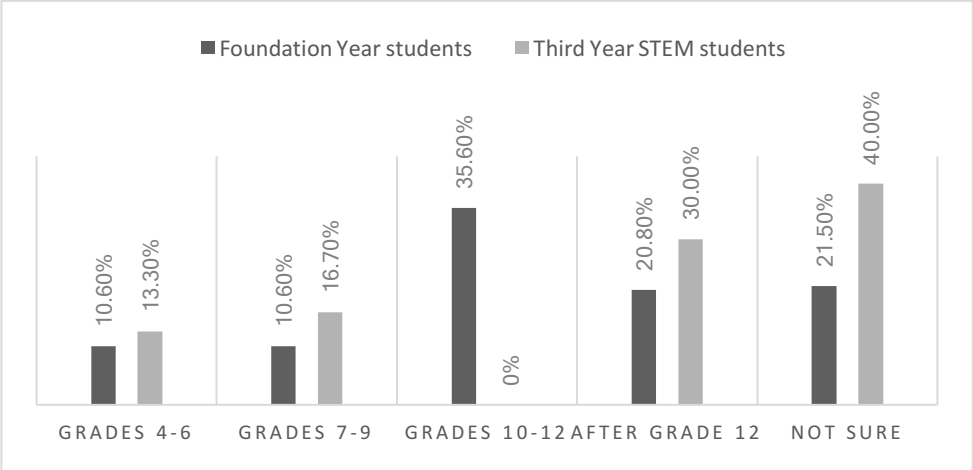
4.3 Personal Aspirations

In this study, the onset of student's aspirations for their chosen career was of significance as an indicator of how their interest in STEM careers was initiated. Identifying the key influences on students' aspirations for STEM careers as they develop has implications for developing strategies to nurture these aspirations, and to ensure that students are academically prepared to enter the science track. Aspirations, according to Khattab (2015), cannot predict students' future career plans, however, they should be encouraged (Greenaway *et al.*, 2017) and supported (Fischer *et al.*, 2017). The onset of student's aspirations was explored at four educational stages:

1. Grades 4-6
2. Grades 7-9
3. Grades 10-12
4. After graduation from high school

Figure 4.2 gives an overall illustration of when the career aspirations of the students in this study began and will be discussed in detail, according to the educational stages.

Figure 4.2 The onset of career aspirations at each educational level



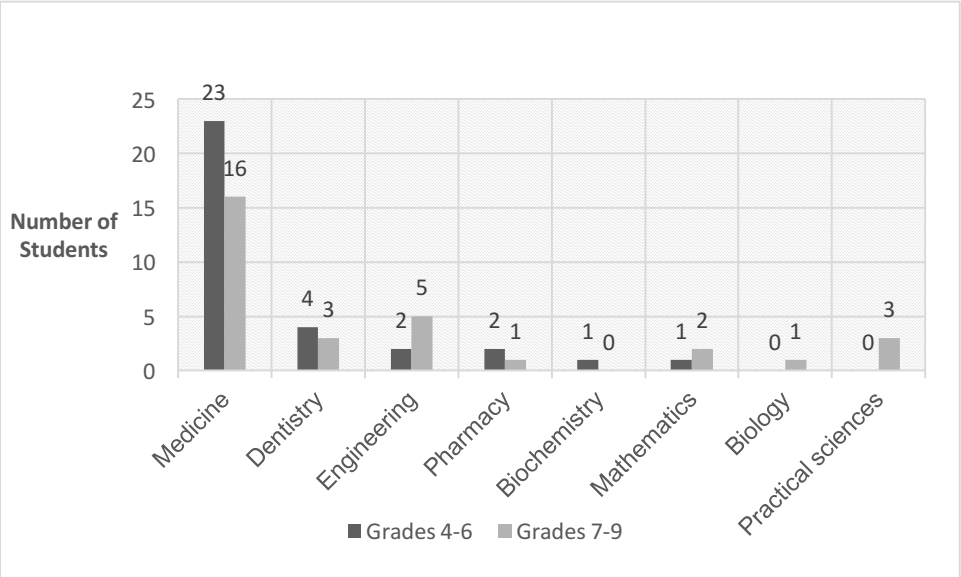
4.3.1 Students' aspirations in grades 4-6 and grades 7-9

In this study, students followed a general curriculum in grades 4-9 (see sections 1.5.1 and 1.5.2). This period (grades 4-9) will hereafter be referred to as the period before studying STEM subjects.

The data reveals a similarity in the percentage of FYS and TYS whose aspirations began between grades 4-9 and after grade 12. However, the TYS were purposefully sampled from specific STEM faculties and were fewer in number than the TYS. Therefore, one must be careful not to generalise these findings, as Yin (2013) reminds us that the goal in a case study is not to extrapolate statistical generalizations. The onset of career aspirations for FYS was greatest in grades 10-12, in contrast to TYS in this study for whom aspirations began before or after this educational stage. It is unlikely that this would be replicated if the sample of TYS was larger and randomly sampled, but that was not the purpose of this study.

The empirical data illustrates the relationship between the onset of aspirations and the specific majors that FYS intended to pursue at the beginning of their foundation year in PMU (See fig 4.3). Interesting trends were revealed; firstly, grades 4-6 students aspired towards six different majors whilst grades 7-9 students aspired towards seven, with the addition of biology and practical sciences. Second, medicine was by far the most popular choice of major for FYS in grades 4-6 and in grades 7-9. Third, more than twice as many students in grades 7-9 aspired towards engineering, compared to students in grades 4-6 (see figure 4.3).

Figure 4.3 FYS aspirations for specific majors before studying STEM subjects



A recent OECD report shows that a significant number of young people across 72 countries want to be medical doctors (Musset and Kurekova, 2018); in most societies, medicine is considered to be a prestigious profession (Treiman, 2013). Thus, assumptions regarding medicine as a prestigious occupation present in Saudi culture (Sembawa *et al.*, 2018) are not exceptional: “Everyone knows that medicine after graduating and working gives you a high status in society” (Dooa-TYS).

Prior to 2005, women in Saudi Arabia were barred from entering fields which were stereotypically masculine, like engineering (AlMunajjed, 2009). Therefore, the availability of engineering majors for women in Saudi Arabia was considered a landmark event. In 2013, one Saudi Arabian Public university offered engineering (El-Sherbeeny, 2014), following the establishment and success of the first department of engineering for women in a private university in 2005/2006 (Effat University, 2018). At that time, FYS in this study were in elementary school, thus the news that a career in engineering for girls was achievable would have been topical amongst women and citizens. The royal decree encouraged women to seek jobs in all fields (Islam, 2014), thus, King Abdullah instigated structural transformations that paved the way for societal changes.

Students in this study attributed their interest in STEM careers to several factors, including watching videos in lessons, reading books, using the internet to find out information, and from life in general. They spoke of having dreams associated with studying medicine and helping people, for example: “It's my dream to be a doctor and help people” (Juwana-FYS): “It is

important for girls to follow STEM careers because they have their dreams that they want to fulfil" (Sultana-FYS). These narratives support the argument of Greenaway *et al.* (2017), who emphasizes that the dreams of children should be encouraged. Gina-TYS stated that it is important for girls to go into STEM careers because girls prefer to help people, as research studies reveal their motivations to work with others, making a social contribution (Eccles, 2013), and fulfilling social values by interacting and helping people (Su and Rounds, 2015). All of these were key determinants in girls' career choices.

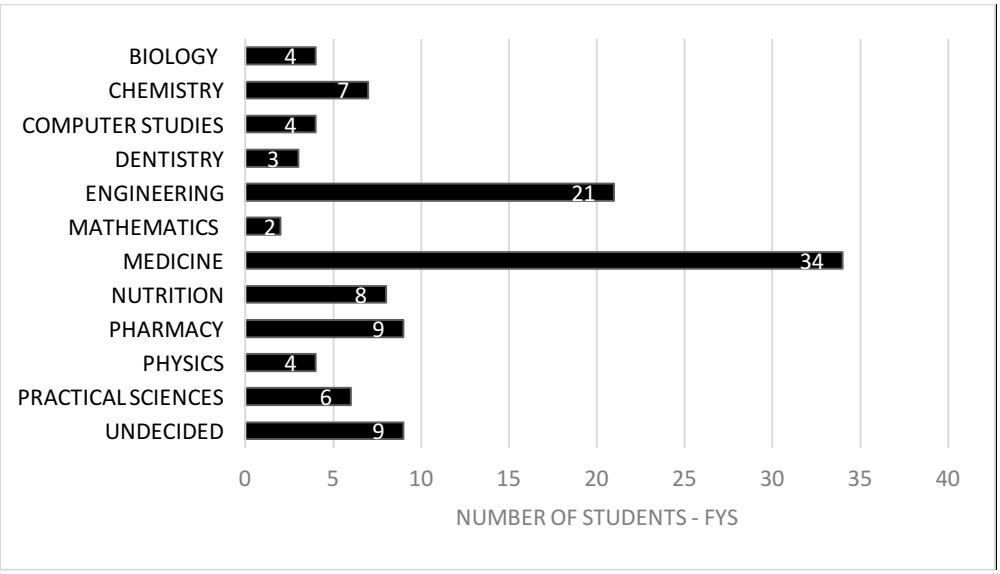
FYS were only inclined towards eight possible STEM careers. This indicates that their knowledge of or interest in other fields which required a STEM education was narrow. This is not surprising since students would have limited exposure to STEM based jobs, visiting healthcare facilities; hospitals, dental surgeries, and pharmacies. They were also introduced to STEM careers through family members working in these fields, like Juwana-FYS: "My uncle is always encouraging me, he is a doctor and he wants me to be a doctor." Similarly, Musset and Kurekova's (2018) study of 72 countries found that most 15 year olds in their study were only interested in a few jobs.

4.3.2 Students' aspirations during studying STEM subjects in high school

Research has shown that approximately half of young people expressing career aspirations at age 15 are likely to end up in a similar type of occupation after 10–15 years in the UK (Croll, 2008) and in Australia (Gemici *et al*., 2014). More than one third of the FYS' aspirations for STEM careers began in grades 10-12 when they were preparing to study or already studying in the science track, whilst most TYS' aspirations began either before grade 10 or after grade 12. The data suggests that FYS started thinking about STEM careers earlier than TYS, which coincides with the massive exit of Saudi Arabian students to foreign countries under the King Abdullah Scholarship Program (KASP) (Reda and Hamdan, 2015). According to Greenaway *et al.* (2017), children cannot aspire to attend tertiary education unless they have knowledge of the opportunities or realise its purpose. Although the participants in this study were not KASP scholars, the evidence suggests that awareness of the program may have influenced their aspirations. Rozek *et al.* (2017) claim that developing competence in STEM subjects in high school is critical as preparation for STEM careers, and whilst the findings of this study support this notion, it is specifically important for students in Saudi Arabian public schools that this competence is achieved by the end of grade 10, when a high GPA defines entry into the science track (DeWitt and Archer, 2015), the only possible route to a STEM career (Adamuti-Trache and Andres, 2008) .

In grades 10-12, FYS aspired towards twelve different majors, with medicine remaining the most desirable profession (see figure 4.4). What is striking in figure 4.4 is the increase in the number of students aspiring to engineering, compared to medicine from 5 in grades 7-9 to 21 in grades 10-12. The students' acquisition of knowledge regarding the commencement of engineering majors for women in Saudi Arabia and the influence of KASP scholars played a vital role in bringing about this escalation in interest. Figure 4.4 also indicates that nine students had not decided on a specific career, though they aspired towards a STEM-related field.

Figure 4.4 Career aspirations of FYS between grades 10 and 12



Computer studies was one of the additional majors in figure 4.4. It is a mandatory subject until grade 10 in the public schools and thereafter the schools may offer it as one or more elective courses. Students are familiar with technology in their daily lives, and this may have sparked their curiosity. Amirah-FM commented on student exposure to the practical applications of computing:

> In public school, they teach them computing from grade 6. They come in knowing what computing is, plus with the smart phones, they know. Some students already have some experience in programming if they were in a school which had activities to teach them to do programming for robots or small applications. So, some students come in with prior background and interest, but that's not the majority.

4.3.3 Students aspirations during studying STEM subjects at university

In this study, just over half of the FYS started the foundation year with aspirations that had been formed sometime before graduating from high school. They were confident that they would pursue their preferred major, but the data revealed several cases in which their aspirations changed within six months of joining PMU. During interviews, it was noted that some students had changed their preferred major between completion of the questionnaire and the interviews; a period of three months during which students also had examinations. This is consistent with Coertjens *et al.* (2017), who noted that transitioning from high school to university usually lasts until after the first formal assessment in higher education.

Difficulties experienced mainly in mathematics (see section 5.2.1) and English (the language of instruction) recurred and were the main reasons for changes. English as a subject was difficult for 18.9% of the FYS in this study, during their high school. This led students to express uncertainty in their confidence to achieve the required GPA: “I am waiting to see how my GPA is before I decide what major I will study” (Rana-FYS). The initial confidence in their abilities to achieve their dreams was, for some students, short-lived. As argued in the literature, there are defining lines between aspirations, expectations, and actual achievement (Khattab, 2015); students’ aspirations are not always realistic, whilst expectations incorporate the reality of fulfilment (Berrington *et al.*, 2016). Both FYS and TYS expressed a limited understanding of course content and academic challenges of a university degree prior to joining PMU, similar to findings related to students in the UK (Rigby, 2017). Raghad-FYS chose sciences because she found them easy in school but experienced difficulties in university. Her perceptions of university studies differed from the reality; consequently, her partial knowledge of the education system (Valadez, 2008) hampered her progress in the science track. Hence, after the first term examinations, she decided to complete the foundation year and thereafter pursue a degree in management.

After joining PMU, the competition for seats on specific courses became apparent to FYS. The uncertainty of maintaining a high GPA led some student to postpone deciding on a major or to opt for less popular majors, thereby securing a seat, as confirmed by Malak-TYS:

> Statistics isn't popular with Saudi girls, maybe they just don’t like it. My lecturer, she has enough knowledge and she made me love the subject because she is professional. In my class, we are just three girls. I like something different that no one is studying.

This was the case for Amirah-FM as well:

> Back in 1999, Computer Science was something new…. Not a lot of people knew about it here [in Saudi Arabia], so I thought, let me study something special and then I will be able to get a job.

In these cases, they used their agency to anticipate their employability based on the limited uptake of girls in statistics and previously in computer science.

Nawf-FM was quite perturbed by the ingratitude displayed by students who failed to appreciate their privileged positions, as she mentioned;

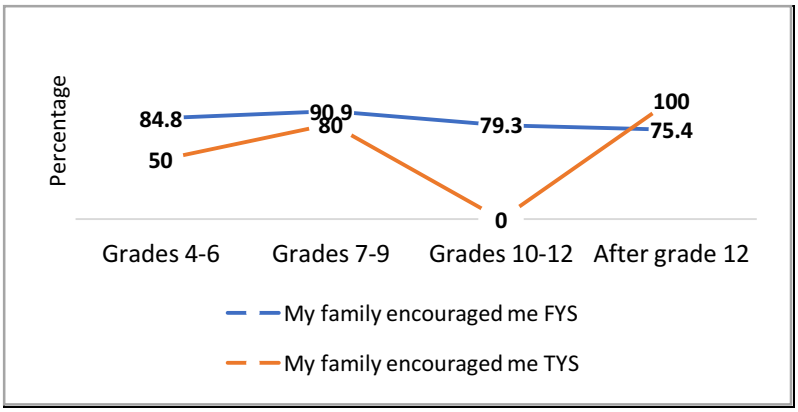
> Some students get accepted into dentistry and then say it wasn't their first choice! Lots of people want to be in their shoes, but they didn't get accepted.

This reaffirms that the most academic students are targeted for the highly competitive majors. Thus, after investing two years studying in PMU, students inevitably enter a major irrespective of their initial aspirations as related by Juwana-FYS: “If my grades are not high enough for medicine, I will study something else. It depends on my GPA at the end of the year.” For many students in this study, their dreams were put on hold or ceased to exist once the reality of university level studies became apparent. Yet, the intrinsic value of achieving a degree elevates their status in society and increases their future employability, despite the job shortages for female graduates (Arab News, 2018). Therefore, students pursue a degree even if it is not their preferred major.

4.4 Family encouragement

As mentioned previously, public school graduates in Saudi Arabia may only pursue STEM majors if they have followed the science track in high school. The data revealed that participants were consistently encouraged by their families in all grades, but for FYS this was most significant in grades 7-9, the preparatory years for the science track (see fig 4.6). It was only after they had graduated from high school and prior to joining PMU that all TYS were encouraged by their families. This demonstrated a shift towards earlier encouragement for pursuing higher education and STEM majors by parents of FYS compared to TYS. The most likely explanation for these observations may be the introduction of new STEM majors in the university, increasing university enrolment, awareness about the KASP scholarship programs (Alhareth *et al.*, 2015), and feedback from its graduates during and after their studies. These may entail discussing strategies such as early exploration of possible careers and exposure to fields of study not typically available in Saudi Arabia. In this study, most TYS had either developed aspirations before grades 10-12 or after (see fig.4.5).

Figure 4.5 The relationship between family encouragement and the onset of students' career aspirations



Aspirations and expectations both have a positive effect on attainment, but when combined they are mutually enforcing (Khattab, 2015). Participants in this study explained how their decisions were influenced to varying degrees by the expectations and viewpoints of parents, older siblings, extended families, and the wider community. Ahlam–TYS stated: "After graduating from high school, I had to continue to study. I can't see myself without studying, and also my family expected me to." In addition, societal expectations appear to have altered since the time their mothers were in school, as, previously, completing high school was the goal for women, which was attained by most of FYS mothers and all TYS mothers, whilst about half of the mothers also achieved a bachelors' degree. The data also suggests that boys were expected to achieve at least a high school education, as all fathers had completed high school. Currently, completing a bachelor's degree or higher is the socio-cultural norm, as Nada-FM points out: "They [girls] must get a degree, because without a bachelors' degree at least, it is so hard to be anything." Nada's statement reflects the unemployment situation of women and how higher education can improve their job prospects.

Although students in this study seized the opportunity to attend university, it was neither an expectation nor a possibility for some of their parents: "My mother is studying [for a degree] now because she didn't have the chance, [or] the time before, because she got married very early" (Juwana-FYS). The main reason for not attending university was marriage during or soon after high school (Al-Hakami and McLaughlin, 2016), yet it is also evident that the government enables them to attend special centres to complete high school certification now: "My mother is now studying high school, she stopped when she got married" (Noor-FYS); "My mother did one year in university but she didn't complete because she got married" (Lama-TYS). Whilst higher education and marriage are not mutually exclusive, family responsibilities took

precedence over studies, especially as women were not expected to work outside the home. In recent years, the average marriage age for girls and enrolment in higher education have both increased, signifying changes to the traditional lifestyle of the Saudi woman. Only one interviewee in this study was married at the time of the interviews. Most students in this study considered early marriage as an option, not the only path available to them.

Irrespective of their own academic achievements, parents in this study were key motivators for their daughters. They encouraged them to pursue a university degree, as Jumana-FYS said: "My parents encouraged me to study and are happy for me to work afterwards especially my father"; and Noor–FYS wanted to be a doctor to fulfil her father's dream, because he had died. Nada-FM explained:

> You know, everyone wants their child to be a doctor. My dad is a big fan of education and wanted the best for us especially as he didn't have a degree. He just got elementary [primary school] education. He didn't pursue higher education and maybe he regretted this later. He was a big push for all of us to finish our bachelor's degrees at least.

From the comments of Nada-FM, we can understand how education has become increasingly important from one generation to the next, and how parents encourage their daughters despite being unaccustomed with the expectations of higher education (Bok, 2010). There is evidence in the current study to indicate that the collective agency of some parents produced a supportive network for their daughter's pursuits, as Gina-TYS said: "I really think it's about the family; actually, my parents made me try everything when I was young. All my community [the parents] were the same," suggesting that they had the same viewpoint with respect to education. These parents encouraged and supported their daughters by providing them with a variety of experiences. This was ahead of the educational and social structures in Saudi Arabia, which were slower to acknowledge the changing social and cultural landscape, including access to information through digital technologies (Al-bakr *et al.*, 2017; Wiseman *et al.*, 2017a).

In many countries, higher education is dominated by the elites, (Croll, 2008; Fischer *et al.*, 2017). While children with low socio-economic backgrounds may not achieve upward social mobility, due to insufficient resources (Khattab, 2015), parents make other sacrifices to encourage and support the upward mobility of their children (Basit, 2012). This was observed in the case of Hanouf–FYS. Hanouf-FYS has twelve siblings, including five older sisters and two older brothers. Both of her parents completed high school; her father works as a school

Haris,[6] while her mother is a homemaker. Hanouf-FYS was proud that her seven older siblings had either graduated from university and have jobs or are still studying for their degrees. Her brothers studied Management and her sisters studied Islamic studies, history, accounting, and computer technology. She also mentioned how happy her parents were that they had all entered university. All education in public institutions is free for Saudi citizens, so the low socioeconomic status of Hanouf's father does not adversely affect her aspirations to be a chemistry teacher or those of her siblings. Thus, in the Saudi Arabian context, socio-economic realities did not adversely affect the aspirations of most students in this study because the government considers it their responsibility to provide education for the citizens. Hence, the structure provided by the state, the agency of Hanouf and her siblings to pursue higher education, and the emotional support of their parents, contributed to the upward social mobility of her family, supporting the findings of Basit (2012).

Selecting an undergraduate major is a complex task. In this study, some parents encouraged their daughters to enter the same field that one of the parents had pursued, as in the case of Ghala-FYS: "My mother studied biology; it is so nice and interesting. She is a biology teacher. I want to be a biology teacher; we have a lot of places where we can work. Women are needed in biology because the girls need to be taught by women." Her narrative demonstrates that her mother's experience as a biology teacher had a direct influence on her. Similarly, Maram-FYS said: "My father, was a lecturer in electrical engineering [and] he encouraged me to study electrical engineering." The network of information within families influenced career choices. Rana–FYS developed an interest in engineering through her brother, an engineer who told her about it. Most of the FYS had older siblings and of those all but one, completed high school and gained at least a bachelor's degree. In addition, all older siblings of TYS completed high school and achieved at least a bachelor's degree. Toleen's–FYS encouragement came from her uncle: "My uncle is an aeronautical engineer, so he also encouraged me and keeps telling me I can do it, be a doctor." Clearly, family science capital influenced their decisions (Archer *et al.*, 2012), where the family includes, not only the siblings (Zhang and Barnett, 2015), but also extended family members.

The formulation of student's aspirations and their motivation to achieve them are guided by a variety of factors. Family encouragement, support, and expectation are all key proponents of students' aspirations, as depicted by the data collected in this study. It also highlights how the interplay between the agency of family members impacted on students' decisions. Furthermore,

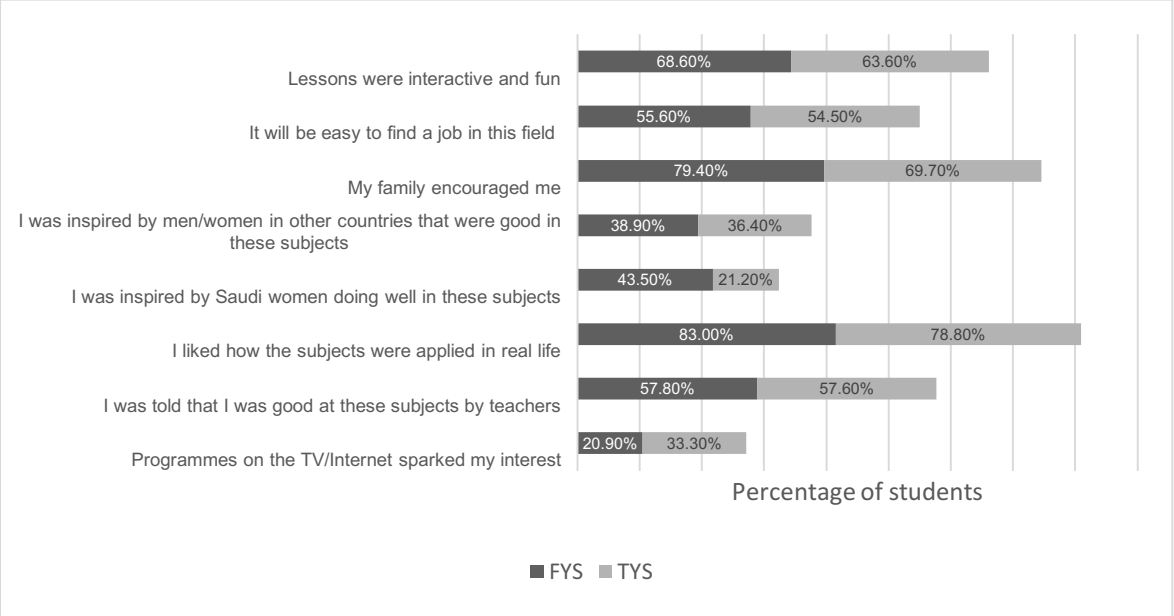
[6] Haris – a school gatekeeper where the monthly salary is amongst the lowest for a Saudi citizen

what is interesting is that both transformation and reproduction of structures are evident (Giddens, 1979). Some students maintained the social class of their parents by pursuing the same career as one of their parents, whilst others achieved upward social mobility by entering university and pursuing more prestigious fields (Treiman, 2013). The effect of each factor on the student's aspirations varied at each educational stage, therefore further analysis was necessary to uncover the variations. This is discussed in the next sub-section.

4.4.1 Factors which influenced Saudi girls to follow the science track in high school

The science track is one of two paths that students can follow for the final two years of high school (grades 11 and 12). Through this research study, the most influential criterion on students' decisions to follow the science track were determined. Figure 4.6 illustrates the FYS and TYS responses to eight indicators regarding possible influences for selecting the scientific track (See Appendix II).

Figure 4.6 Main influences for selecting the science track



4.4.1.1 School subjects related to life

The data revealed that when science subjects are related to real life, they positively influenced the students in this study, supporting the findings of Eccles (2013) and Su and Rounds (2015). The data indicates that the connections students make between subjects and life is a significant contributory factor to the development of STEM interest, particularly in the early grades, 4-6. The fact that students in this study prefer subjects whose applications are clear is understandable. Furthermore, in elementary school general science concepts tend to be

taught in context to real life. However, as students progress through school, scientific theories and more abstract components of courses may be less appealing and their applications obscure (Bottia *et al.*, 2015), resulting in an aversion to some subjects (Archer *et al.*, 2017a).

4.4.1.2 Family encouragement

As discussed in section 4.3, family encouragement was one of the key influences in students' decisions to pursue the science track and subsequently STEM careers. Notably, the influence of Saudi women doing well in STEM subjects was much greater for the FYS than the TYS, as female participation in STEM fields had increased (Reda and Hamdan, 2015). This then lends support to the idea that family members studying overseas were a source of encouragement (Hall, 2013) for the FYS and female scientists were becoming more prominent (Islam, 2014).

4.4.1.3 Lessons were fun and interactive

Grades 4-6 and grades 10-12 were key junctures where FYS found lessons enjoyable and a high proportion of TYS held the same experience after joining PMU. Enjoyment of subjects influenced the scientific major choices and future career plans of females, as highlighted by Foote and Garge (2015); however, as Badri *et al.* (2016) argue, enjoyment alone has limited effect on student's choice to pursue STEM careers. Practical experiments were one measure of students' enjoyment in science lessons: "I enjoyed watching when my teacher did experiments. I wished that I could do the experiments" (Jumana-FYS); "The school had many supplies and everything for us but really, we didn't use them. Maybe because there was no technician, but the equipment was there" (Waad-TYS). These narratives expose the variation in pedagogical strategies employed by individual teachers and embedded in institutions (Alghamdi and Al-Salouli, 2013). This is discussed further in section 4.5.4.

4.4.1.4 Employment prospects

Interestingly, as early as grades 4-6, many FYS's decisions were influenced by how easy it would be to find a job, whilst this gained more importance for TYS after grade 12 when considering potential majors and future careers. The high rate of unemployment of Saudi women (Arab News, 2016a) did not deter the participants from their aspirations, as they were aware of the shortage of jobs for women (Omair, 2012). While they were currently concerned, they were hopeful that jobs would be available by the time they graduate. Musset and Kurekova (2018:9) maintain that, "Young people's career aspirations are commonly poorly aligned with actual labour market demand." Whilst this cannot be disputed, ongoing adjustments to the labour market in Saudi Arabia to accommodate more women has led to the current ambiguity surrounding the areas of demand.

4.4.1.5 Teachers' influence

Building on students' ability and effort through praise, discussion, or reflection can lead to positive self-belief and increase motivation (Mujtaba *et al.*, 2018). The data revealed that teacher's positive comments were critical mostly in elementary and middle school and then after grade 12, on joining PMU. Teachers played a vital role in students' decisions by motivating them, as Abeer-FYS commented:

> I love this subject [chemistry] because of my chemistry teacher in high school. My chemistry teacher was nice, and she is of a good age [experienced]. She told me about her subject and encouraged me. She said I should study chemistry because of my high grades. My chemistry teacher had the most influence on my decision.

4.4.1.6 Male and female STEM professionals in other countries

Often young people are inspired by famous people that they may have seen or heard about in the media. This indicator was essentially posed to determine if students were inspired by famous scientists from countries other than Saudi Arabia. It has been reported in the literature that students in the USA are motivated to pursue the sciences after hearing stories about famous scientists like Einstein (Lin-Siegler *et al.*, 2016), and the struggles and achievements of other scientists give the students a sense of connectedness to their own struggles or aspirations. The data in the present study revealed that more than one in three participants selected this indicator. However, as mentioned previously, KASP was a huge endeavour that affected most extended families to varying extents. In relation to this indicator, participants were considering KASP scholars as the male and female STEM professionals that they were inspired by in other countries, rather than non-Saudis. This highlighted the positive impact of KASP scholars on the aspirations of school students who were familiar to them and the potential benefits of cascading information about their experiences and careers to a wider school aged audience.

4.4.1.7 Female Saudi Arabian STEM professionals

Many students in this study were encouraged to follow the science track by hearing about Saudi women doing well in STEM subjects, but not necessarily in their chosen fields. Abeer-FYS pointed out that the successful Saudi women she was referring to were not famous women but were personally known to her. For example, she spoke to her cousin who is studying engineering. Similarly, Lana-FYS spoke to her chemistry teacher; Sultana-FYS spoke with her sister and other friends; whilst Nadia-TYS spoke to students who had graduated from PMU. Although there are several prominent female Saudi scientists and doctors (Department

of Planning and Statistics, 2010; Islam, 2014), many students had the same comments as Hanouf-FYS: “I don’t know any Saudi women working in these fields.” Clearly, this suggests a need to address how information about these prominent scientists is disseminated to the public, as they could serve as role models to enhance the interest of students in STEM fields (Foote and Garg, 2015).

The perceptions of who students in this study viewed as Saudi women doing well in STEM careers varied widely. As can be seen in most cases above, the Saudi women that influenced the students’ decisions were other students, friends, teachers, and family members. All participants in this study and teachers in Saudi public schools are Saudi Arabian subjects. Despite the high regard that students held for their teachers, the data suggests that most students did not classify their teachers as Saudi women doing well in STEM careers. Furthermore, whilst teaching is viewed as an appropriate career for Saudi women (Syed and Van Buren, 2014), the advanced technical skills associated with many STEM careers are not generally required for teaching in schools, which adds to the debate regarding what is classified as STEM (Eccles, 2013).

4.4.1.8 Television and Internet programmes

The data analysis revealed that for FYS grades 4-6 was the period where they were more susceptible to all the defined influencers in this study. TYS were more influenced by TV/internet programmes than the FYS, although it was one of the lowest influencers for both groups. Furthermore, the influence of this indicator diminished after grades 4-6, indicating that it would be most effective in developing STEM interest prior to grade 7. Yet, with the current drive to effectively implement ICT in schools (Alenezi, 2015), students will be able to access advanced e-learning platforms at home, too (T4EDU, 2018).

Decision-making often involves using more than one strategy. Saudi girls and women spend most of their time in gender-segregated environments, and interactions therein influence their decisions, including those related to careers. The data highlights the fact that Saudi women and men who are successful in STEM fields can have a significant impact on the STEM aspirations of Saudi girls. It was surprising that the data did not reveal a relationship between schools and home, and more specifically mothers, as fathers are prevented from entering girls’ schools. This can be problematic, as parents need to know what is involved in the educational process that would support their child (Crozier, 2016). This is discussed further in chapter 5, where the data indicates that many schools did not hold meetings with mothers regarding their daughter’s career planning. It was easier for the girls in this study to envision men working in

certain fields than women, as the job market is tightly regulated and still limited for women (Al-bakr *et al.*, 2017), although this is changing (Kinninmont, 2017).

Gaining entry to the science track is critical for students aspiring to STEM careers. There are implications for how students may become informed and interested in STEM careers. As mentioned earlier, students are more interested when subjects are related to real life. Engaging lessons delivered by well informed, teachers can be a mechanism to highlight where subjects fit into real jobs, as these may not be obvious, as found in New Zealand (Mills, 2013).

Students following the science track in high school are eligible to apply for undergraduate STEM majors, subject to successfully completing high school in addition to passing standardized national entrance examinations i.e. *Tahsili* (science based) and *Qudraat* (IQ based). Students in the science track are largely the most academically able in their respective schools. A combination of factors, including their high school experience, shaped their decisions to pursue the STEM (science) track or to enter a non-STEM (Administrative or Arts) track in PMU. For Raneem-FYS, the science track was a crucial path to studying medicine; Hanouf-FYS liked to do experiments [in school] and things like that; and Juwana- FYS enjoyed the sciences most in school and got good grades. Grades were critical in gaining a place in the science track, as Atheer-TYS confirmed that her decision was based on the high grades she secured in mathematics. A STEM career is therefore possible only after entry into the science track has been accomplished.

The next section gives an insight into participants' experiences in high school as they prepared for university entrance.

4.5 Educational experience

4.5.1 High school experience

All public schools and universities in Saudi Arabia are single-sex environments; girls are taught by women and boys by men. International schools in Saudi Arabia may have co-educational or single-sex environments. It has been argued that same-gender teachers can have a positive effect on subject appreciation (Lee *et al.,* 2017), but this is not conclusive and there is little evidence to suggest that student achievement is enhanced (Cho, 2012). All participants in this study attended single-sex public or private Saudi Arabian schools. Proponents of single-sex education believe that girls benefit from being taught separately from boys, leading to increases in achievement, academic interest (Booth and Nolen, 2012), confidence, and active participation in classes (Ofsted, 2011). However, this view has been refuted by some research

studies (Pahlke *et al.*, 2014). Co-educational schools are one of the main settings within which gender comparisons regarding abilities in subjects like mathematics and physics usually occur, by students and inadvertently by teachers (Wang and Degol, 2017).

Since girls and boys in Saudi Arabia are equally exposed to the same mathematics and science curriculum, in separate schools, girls do not associate sciences as being for boys (Adamuti-Trache and Andres, 2008; DeWitt and Archer, 2015). However, to guide educational improvement, statistical comparisons are made at the governmental level based on international tests such as TIMSS (Mullis *et al.*, 2016b), which is not shared with students. Consequently, marginalisation of girls by boys is not a cause for concern in the Saudi Arabian schools. Thus, in this study, students' perspectives on their high school experiences and the subjects that they studied were not limited by stereotypical constraints.

Generally, students enjoyed high school: "I loved high school of course! The program and the teachers were good or excellent; that's what I liked" (Lina-FYS); "Beautiful days in high school. I liked my teachers: mathematics, physics, chemistry, biology" (Yasmine-TYS). Some students like Malak-TYS, had mixed feelings: "I enjoyed high school, but I didn't like the science labs and the physics, I didn't like it because we didn't have proper laboratories."

Participants who attended private schools studied a wider range of subjects, incorporating both STEM and non-STEM courses, without the need to decide on a specific track:

> I felt that I was pressured in high school, I was in a private school and a *Mawhiba* scholar.[7] In my high school, they helped us to increase our confidence, to be open to everything and participate in everything. Our teachers also gave us advice. We could tell that there was a difference in our educational level compared to the other students [at university]. In the foundation year it was easier for me and my friends. We were repeating some subjects that we had already taken. (Dooa-TYS).

4.5.2 STEM subjects

Previous research challenged the notion that girls were less competent in mathematics than boys (Wang *et al*., 2013; Wang and Degol, 2017) and they perceived physics to be difficult (Taylor, 2015; Francis *et al*., 2017). In this study, it was important to determine if students' favourite and difficult subjects influenced the undergraduate STEM majors that they chose to pursue. Participants from public schools in this study followed the science track, with a

[7] A *Mawhiba* scholar – is a gifted student who studies in main stream school following an advanced Supplementary curriculum and is the recipient of a scholarship from the Mawhiba foundation

restricted curriculum. Table 4.1 and Table 4.2 illustrate the subjects that FYS considered as their favourites and those in which they experienced difficulties, respectively. Students are taught in Arabic in public schools and, in private schools, they may be taught in either language. The language of instruction for STEM majors is English in PMU and all universities in Saudi Arabia (Al-Asmari and Khan, 2014). Thus, English language competence is a key component in the successful academic achievement of FYS in STEM-related courses in PMU, and subsequently affects the major they can pursue.

The data revealed that most students had at least one favourite subject and almost all had at least one subject that they found difficult. Table 4.1 shows the frequency for each subject; participants could select more than subject. As the sample sizes of the two groups were uneven, the percentages are not directly comparable. Therefore, both frequencies and percentages are presented, as suggested by Cohen *et al.* (2011).

Table 4.1 Favourite subjects

Subject	FYS (n=312)		TYS (n=30)	
	N	Percentage	N	Percentage
Mathematics	144	46.5%	17	50.0%
Chemistry	113	36.5%	9	26.5%
Biology	97	31.3%	10	29.4%
English	53	17.1%	9	26.5%
Physics	49	15.8%	10	29.4%
Computer Studies	49	15.8%	4	11.8%
Other	32	10.3%	1	2.9%

Mathematics was the most favoured subject for both FYS and TYS. Talia-FYS liked everything in high school, especially math. Shaden-FYS liked working with numbers. Physics and computer studies were the least favoured by FYS, with Computer studies least favoured by TYS. Rawan-TYS recalled:

> I didn't like computing in high school, the subject is very different from the major computer science [at university], but I chose it as a major because of the programming. I like to create computer programmes.

Computer studies is mandatory in grade 10, but, in grade 11 it may be offered as an elective course only. Despite the importance of technology in daily life, and students' positive attitudes towards technology, Rawan-TYS highlights that computer studies courses offered in schools

are poor preparation for higher education. Alothman and Robertson's (2015) study of Saudi high schools shows that teachers had variable computer technology skills, and usage was dependant on readily available technology in the classroom and the teacher's self-efficacy. It also illustrated that some teachers relied on students who were more acquainted with technology to prepare presentations. Thus, the authors concluded that the existence of computer technology in the classroom does not mean it will be used efficiently.

In the UK, the most popular STEM related A' levels for girls in 2015/16 was biology, chosen by 18%, followed by mathematics, by 17%. For the same year, 30.8% boys studied mathematics and 13.5% studied biology, the fourth most popular subject after chemistry and physics (Department for Education, 2017). Often, these choices are based on ability, interest, and perceived earnings (Davies *et al.*, 2017). In the current study, physics and biology were equally popular with the TYS, implying that the subject preferences of the participants in this study were less gender-stereotypical than in other research studies, see Francis *et al*. (2017) and Department for Education (2017). Malak-TYS explained why she chose to study statistics rather than science in PMU:

> Hmmm... yes, we did some experiments but not as much as we would have liked. If I had done more experiments, and had bigger laboratories in science, I still don't think I would like science more than math. I believe that it is just about individual likes and dislikes.

Furthermore, students may be academically able in subjects that were not their favourites. When asked about her favourite subjects in high school, Lama-TYS, who is majoring in physics, said:

> I was good in physics, but it wasn't my favourite subject. Physics wasn't my first choice of major, I wanted to study practical science and technology, but I prayed *Istikarah*[8] and I found myself on another path. I am fine though, I really enjoy it.

Thus, Lama-TYS relied on her beliefs and Islamic practice. This shows that, in addition to other sources of guidance, religious agency can steer the girls to a different course than they had envisioned.

[8] *Istikarah* is a special prayer to ask God to guide one to do the right thing concerning any affair in one's life, especially when one must choose between two or more equally appealing and permissible alternatives, e.g. a career choice, getting married. Source: Fiqh-us-Sunnah, volume 2, number 32 and volume 4, number 141

The data shown in table 4.2 illustrates that physics was the most difficult subject overall for FYS, followed by mathematics, this is consistent with research in the UK on the post-16 participation of girls in physics (Archer *et al*., 2017b). However, TYS found Biology, Chemistry and English more difficult than physics.

Table 4.2 Difficult subjects

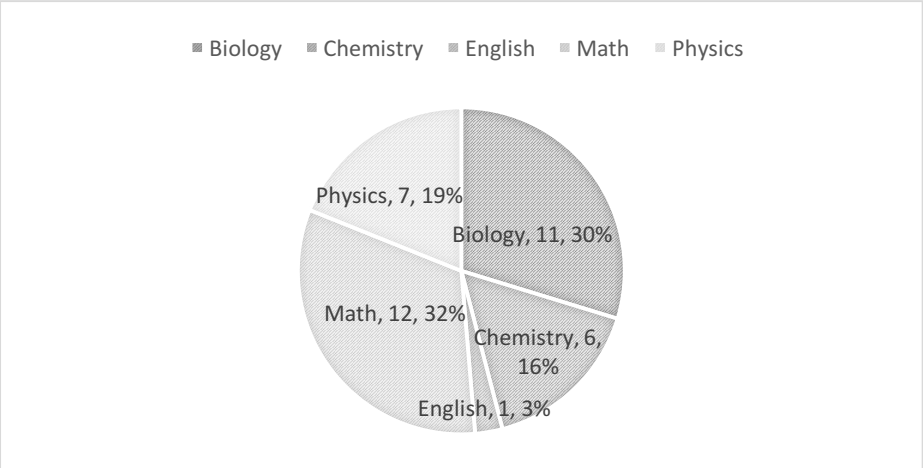
Subject	FYS (n=312)		TYS (n=30)	
	N	Percentage	N	Percentage
Physics	116	39.9%	7	24.1%
Mathematics	70	24.1%	2	6.9%
Biology	66	22.7%	9	31.0%
English	55	18.9%	9	31.0%
Chemistry	52	17.9%	9	31.0%
Other	28	9.6%	0	0
Computer Studies	23	7.9%	3	10.3%

Ayalon (2002) argues that in some countries the high uptake of science and mathematics courses is not necessarily voluntary, especially in public high schools. This is the case for science track students in Saudi Arabia, as they study all the sciences and mathematics courses, which contrasts with the UK context mentioned above where students can select the subjects. Therefore, the restricted curriculum guarantees that a high proportion of high school students are academically prepared to pursue STEM-related careers.

A noteworthy finding was that 11.85% of the FYS (36) experienced difficulties with their favourite subjects (see figure 4.9). They explained how they overcame the difficulties through hard work and consulting the teachers: “I liked math and physics and I worked hard, but in the last semester of grade 12, physics was difficult. I worked hard because I still liked it and I managed to get overall 100%” (Toleen-FYS); and “High school was difficult, but my teachers helped me especially my math and biology teachers; I loved math” (Noor-FYS). Earlier research suggests that students perceive their struggles in the science class as an indication that they will never be successful in science (Dweck, 2012); conversely, in this study, students worked hard to overcome challenges, thus their agency was driven by their desire to succeed (Giddens, 1979; 1984).

Although there are various aspects about the subject(s) that captured the students' interests, the motive for their perseverance is the utility values of these subjects being key to their future careers (Harackiewicz *et al*., 2012; Rozek *et al*., 2017; Mujtaba *et al*., 2018). This is congruent with recent studies in Finland where a determining factor in selecting STEM courses is the importance which students attribute to specific courses for their future careers (Juuti and Lavonen, 2016; Lauermann *et al*., 2017).

Figure 4.7 High school students who found their favourite subject difficult



The data revealed that although more than half of the survey participants expressed a partiality to mathematics, very few aspired towards a career in mathematics. Students' choices were adversely affected because careers in mathematics were poorly understood, even though the recent 2030 vision highlights the need for statisticians.

4.5.3 Teachers' Style

A recent study shows that students mostly recall their favourite teacher as warm and kind-hearted (Boshier, 2017). For the FYS, it was important that they had teachers who were kind and approachable. Students felt encouraged by these teachers, as Raneem-FYS explained: "My teachers were very kind. If I didn't understand something, I would go to them; they helped me and encouraged me." Lana-FYS intends to major in chemistry and was inspired by her teacher: "My chemistry teacher kept telling me that I am good, and I will do great things in chemistry in the future." Other students commented on the impact of their teachers on their learning. "The teachers supported the students very well" (Maram-FYS); "The way that teachers taught influenced my choice of major because my teachers helped me if I found anything difficult and explained things to me" (Sama-FYS).

Students were positively influenced by the teachers' unique styles of teaching:

> I had difficulty understanding the lessons in some subjects, but my chemistry teacher in the second year [grade 11] was very good. She didn't do any experiments or use interactive techniques, just talking and using the school book but, the way she explained the subject matter was what made [the] students understand. Some teachers explain, but the students cannot get it, because the explanation method is not clear (Hanouf-FYS).

Other participants also referred to the pedagogical practices of specific teachers when narrating their love of a subject like Toleen-FYS who spoke about physics: "I liked how I was taught physics. My teacher was so creative, not just using books all the time. We did experiments and other activities."

4.5.4 Pedagogical practices

The Saudi public education system has previously been criticised for its strong emphasis on rote memorization (Chapman and Miric, 2009; Unruh and Obeidat, 2015), whilst Saudi private schools tend to adopt pedagogical practices in which critical thinking is encouraged, and European and North American curricula are followed (Rabaah *et al.*, 2016). With the implementation of revised curricula in mathematics and sciences by the MoE in 2010 (Alghamdi and Al-Salouli, 2013), and master training programs (Miller, 2014), several teachers received training on how to diversify and enhance their pedagogical skills (El-Deghaidy *et al*., 2017).

When asked about the style of teaching in their high school classes, most FYS were taken aback, as they had not really thought about it previously. As Blaike (2009) notes, much of the activity in life is routine and is conducted in a taken-for-granted unreflective manner. However, on reflection, students recalled a range of teaching strategies used in their schools, such as, watching videos, carrying out experiments, watching demonstrations of experiments, using computer software, doing research, and using the internet. Noor's comment indicated that interactive lessons were the norm in her public school:

> We did activities of course; we used computers, and in math lessons, we did problem solving. All the teachers used computers, but we also watched videos, we did research and we did experiments in the lab.

Likewise, Raneem-FYS was quite excited when she recalled her science lessons: "They taught us courses using the computer, projector and we had labs for chemistry, physics and biology. We did experiments, we handled apparatus especially in biology, we touched the animals, they were dead!"

In some public schools, teachers still taught using traditional teacher-centred methods. Dana-FYS recalled: “My lessons in high school were not interactive but, I enjoyed them sometimes. I liked chemistry, biology and Arabic.” This implies that Dana-FYS may have enjoyed her lessons more if they were more engaging. Where lessons were interactive, it appeared to be dependent on the agency of individual subject teachers: “We didn’t do any experiments or anything like that. Math and science lessons were interactive, but not all subjects. We used computers in science” (Shaden-FYS).

Students who attended private schools had diverse experiences, very different from their peers who attended public schools, as Nadia-TYS mentioned: “Our lessons were interactive; the teachers gave us research, essays, reading, we used the internet, and did experiments; we were doing it a lot.” In addition, Dooa-TYS explained how teachers instilled in them the need to apply the knowledge that they gained:

> In high school, classes were more interactive, more student driven to get the information. The teachers gave interactive lessons and we had to understand so that we could apply the information everywhere.

Those who attended a public school observed: “In science we did little experiments, not too much. We didn’t do research, not all teachers used interactive methods in our lessons” (Rawan-TYS); “Sometimes we had presentations and activities in high school; we prepared some projects [artefacts], then we went to a primary school and we showed [the children] how to save the environment” (Atheer-TYS).

A wide variation in pedagogical strategies exist across schools and within schools but were more varied and consistently used across subjects in private schools. The narratives both support and challenge the notion that rote memorization is still practised in Saudi Arabian schools. While lessons could be interactive and fun; in public schools, it was dependent on individual teachers rather than whole school policies, with a few exceptions. Furthermore, this indicated that most teachers are working independently, rather than collaborating and sharing good practice.

These narratives shed light on the varying degrees of interaction students experienced in their high school lessons. For these students, modern pedagogies were stimulating, but, clearly, the utility value of the subjects was of utmost importance (Harackiewicz *et al*., 2012; Rozek *et al*., 2017). All students in this study excelled in the science track in high school and pursued STEM education in PMU, indicating that successfully graduating from the science track was the priority, while enjoyment was a secondary factor. Juuti and Lavonen (2016) also found that

there was little correlation between pedagogical practices and intention to enrol in STEM majors in Finland.

For public school students in Saudi Arabia, career aspirations in the broadest sense, science or non-science, need to be consolidated before or during grade 10. More importantly, for pedagogical practices to spark interests in STEM, those practices must be established by all teachers starting from the earliest grades, to ensure their consistent and routine use in subsequent grade levels.

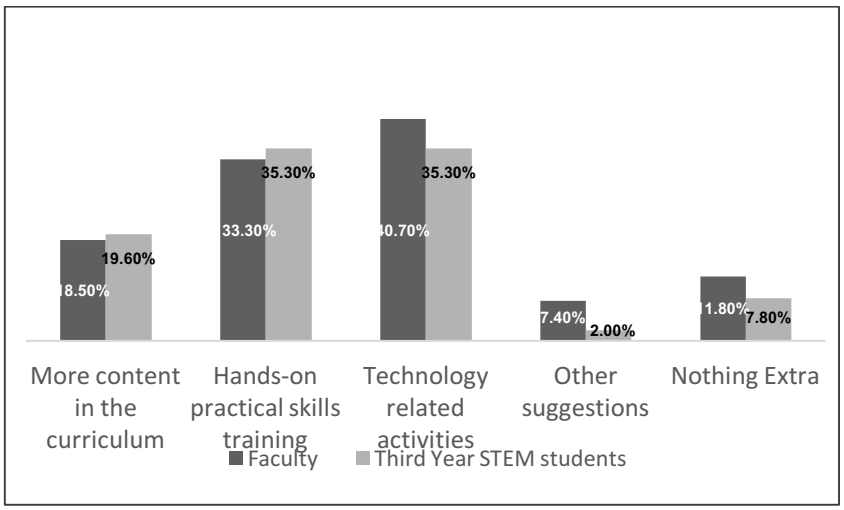
4.5.5 Factors that make STEM subjects interesting in high school

In the current study, the students' high school science educational experiences varied considerably. In many cases, students had supportive teachers whose lessons were fun and interactive, with interesting content. This motivated them to work towards realising their aspirations and achieve high grades. On the other hand, rote memorization and limited access to practical work made the experience less interesting for others. This suggests that encouraging more high school students to enter STEM fields, could be facilitated by adjusting the education they receive. This is consistent with the view of Aljughaiman and Ayoub (2012):

> The current curricular content delivered in the majority of the schools [in Saudi Arabia] is focused on traditional areas of academic achievement, and hence does not emphasize improving practical intelligence (Aljughaiman and Ayoub, 2012: 168).

The perceptions of FM and TYS on how STEM education could be improved in schools were explored, as illustrated in Figure 4.10. Furthermore, whilst broad generalisations cannot be made beyond this study, consideration of these recommendations could help schools to effectively prepare students for their undergraduate studies. Additionally, these recommendations have implications for devising and implementing strategic planning and policies by the MoE. The TYS' reflections on their own high school experiences indicate that their high school preparation and subsequent transition to university was overall positive. Moreover, drawing on the wealth of educational experience of FMs (which ranged from 4 to 38 years) the data gives useful insights regarding recurrent deficiencies in the high school preparation of students and possible solutions.

Figure 4.8 Recommendations for improving High School STEM subjects



The views of TYSs and FMs followed a similar trend, as both groups recommended that high schools incorporate more technology related activities into lessons, and secondly, enforce hands-on practical skills training for students. Training students to have the practical skills to conduct experiments and using technology would enhance their preparation for the foundation year where laboratory sessions are mandatory and multimedia resources are incorporated in lectures. They also agreed that the school curriculum provided a good base for higher education, apart from computer studies. It is presumed that, should these measures be enforced in schools, students would be better equipped for entering PMU with enhanced skills to supplement the required high GPA. Furthermore, as students that graduate from the science track may apply to any of the foundation tracks offered in PMU, these strategies might encourage science track students to continue in the same track in PMU.

4.5.6 Academic achievement

Achieving a high GPA was one of the fundamental requirements for joining PMU. Students allied their grades to their love of specific subjects: “I love chemistry and I got good grades. I got a GPA of 97% overall (Lana-FYS); “I got good grades in biology and chemistry” (Sultana-FYS); “Math was one of my strongest subjects because my mum is a math teacher as well. I always got a full mark” (Malak-TYS). Research in the UK has suggested that student motivation can also be increased if teachers engage in research of their own teaching practices and their students’ learning processes within their respective subject areas and school context (Christodoulou, 2017). PMU implemented changes in the pedagogical strategies employed by faculty members to eradicate the less engaging techniques as Nora-FM commented: “Even in

the university we have had to make changes in the way that we deliver courses." Amirah-FM explained:

> I think it [teaching] is different from before. It doesn't only depend on the board and just explaining. We use technology like programming, MATLAB[9] …..... In our computer lab for the students, we use different styles of teaching. We have training to change our styles of teaching which is good. A lot of people (faculty) are coming from a Western way of teaching ….... now the students argue with the teacher, they have this confidence in themselves, without feeling that the doctor will shame them or something.

Numerous strategies have been, and continue to be, employed to encourage girls to pursue STEM careers in the UK (Macdonald, 2014), including parental engagement (Fischer *et al*., 2017; Leithwood and Patrician, 2017) and outreach initiatives (Bagiya, 2016). In this study, the consensus of participants was that Saudi girls did not need to be encouraged to follow STEM education; many are already motivated and, moreover, it is a personal choice. As Juwana-FYS related, "It's not necessary to do anything to encourage girls to follow STEM careers, they are already interested." This view was supported by Sama-FYS who was conscious of the high uptake in STEM fields: "I don't think girls need to be encouraged to follow STEM careers, I think they will do it if they want, there are already a lot of them." Individuals in the same or different social system have different conceptions of social structures, therefore, the viewpoints expressed in this study are those who previously decided to pursue STEM education. Despite the huge uptake of STEM education by Saudi girls, it would be presumptuous to assume that more students could not have been persuaded to follow this track.

Ahlam-TYS felt that more girls could be encouraged to enter STEM careers and education by talking to them early about jobs and understanding how the degree courses will help them. The students' views were supported by Nora–FM:

> They [the girls] are encouraged. There are a lot of students and [PMU] is selective, the numbers are big, and we are still at the beginning, so we can't take all of them. This is evidence that students really like to join these fields and we [offer] these majors for girls in a separate campus [from the boys] so nothing discourages a girl from joining what she wants.

According to Su and Rounds (2015), gender differences in interest vary largely by STEM field; women tend to go towards STEM fields with a people-orientation work environment. However, where STEM fields have a things-orientation work environment, such as engineering, it may

[9] MATLAB (matrix laboratory) is a multi-paradigm numerical computing environment and fourth-generation programming language.

be necessary to develop strategies to encourage girls to enter those STEM fields (Su and Rounds, 2015). Nora-FM explained that PMU students visit some local high schools and give the school students an idea about the engineering colleges. During these visits, the PMU students give sessions about what engineering is and how students can prepare themselves to join the college. She also mentioned that although this outreach was not able to cover all schools, other curious high school students often sought information from available resources including the PMU website or faculties. Thereafter, they could assess their options before selecting a preferred major through reflexivity, as advocated by Giddens (1984) and Archer (1995).

4.5.7 Curriculum development

From the FMs' perspective, the Saudi Arabian high school curriculum provided enough background for the FYS, except in computer studies. Additionally, one of the objectives of the foundation year programs is to fill any gaps in specific curricula, to compensate for the different high school curricula. Concerning computer science, Rawan–TYS affirmed: "They should develop the subjects in high school and talk to them [high school students] about careers so that they can get the right idea about computer science. Computer studies as a course is mandatory for students in grade 10, with optional elective courses offered in grade 11 or 12. Consequently, for girls to envisage technology related careers as attractive possibilities for themselves, both the curriculum content and the time allocated to computer studies in schools need to be addressed.

Education in Saudi Arabian public schools takes place in formal classroom settings. Faculty members suggested that schools extend learning beyond the classroom to demonstrate the link between subjects and STEM fields:

> If [the schools] could take the students from time to time to see how research is carried out, this would be great. To see how scientists are proceeding with their research is something good. Take them to the laboratories in hospitals, even the university hospital to see blood analysis to open their minds. We don't have such things in our public schools, maybe not even in the private schools. All the field trips[10] are just to have fun (Huda-FM).

Extracurricular activities were not offered to students in this study, except two who were *Mawhiba* scholars and who participated in programs organised through Mawhiba, not the schools: "*Mawhiba* made me communicate with the community we had a lot of good

[10] Field trips are any event where students are outside of their usual school environment. These are restricted in Saudi Arabia

experiences, we met many people that we wouldn't have, for example, prominent members of the royal family" (Gina-TYS). The participation of members of the royal family signified the importance afforded to the *Mawhiba* program and illustrates the effect of the program in fostering collaborations between scholars and the wider STEM community. Clearly, the extracurricular aspects of the program were most beneficial for the scholars as Dooa-TYS highlighted:

> The [*Mawhiba*] curriculum didn't influence my choice of major because we studied many courses, both arts and sciences but the activities and competitions had a huge influence, a good influence.

Smith (2011) found that although enrolment in STEM enrichment programs had been promising, they have done little to increase the uptake of STEM careers by girls in the UK. Also, the timing of initiatives is crucial for developing early interest and giving adequate time for academic preparation for STEM careers (Silim and Crosse, 2014), as emphasized in student feedback following the Saudi Women in Technology Program (SWTP) (see chapter 2.7.6.3).

4.5.8 The language of instruction

As mentioned previously, the language of instruction for STEM subjects in Saudi public schools is Arabic. In public schools, students start to study English as a language in grade 6, and a strong emphasis is placed on grammar and vocabulary, using textbooks that focus on accuracy rather than fluency (Allehyani *et al.*, 2017). A recent study reported that Saudi students in English classes are rarely involved in self-directed activities; and they demonstrated high levels of teacher dependency and low levels of learner independence (Alrabai, 2017). This limits students' ability to understand STEM subjects in PMU where the language of instruction is English. This was mentioned by Maryam-FM who commented:

> I wish [the high schools] would teach chemistry in English, not Arabic because the students have difficulty with the terminology [at university] especially if they come from public schools.

This was verified by Amirah-FM who explained that one of the things that changed at PMU is that all the STEM courses are taught in English and teachers speak in English. The use of English as the language of instruction is a real problem for some students: "The words in biology are so difficult for me" (Lana-FYS). Malak-TYS reiterated this point as she reflected on her foundation year in the university:

> We have some teachers who never spoke Arabic [in lessons] and that was a big problem. In the English classes it was a problem, I couldn't talk to them [the teachers]; language has been an issue.

When Lama-TYS spoke to her younger cousin who is in high school, about her future career plans, her cousin mentioned that she would prefer to go abroad to learn English and improve her communication skills before joining university in Saudi Arabia. This is not a new problem, as Amirah-FM also found language to be a barrier in her early career:

> To be honest, at the beginning the biggest challenge for me was my English, it wasn't good. It's funny in computing because all the books are in English, but the teacher taught us in Arabic.

There has been much debate regarding the use of native language as a tool in teaching English language (Cook, 2016). According to Al-Nofaie (2010), the use of Arabic language in teaching English was an unavoidable phenomenon, although excessive use has disadvantages. Cook (2016) argues that first language should not be used in second language learning environments. Evidence from recent research indicates that the experience of Amirah-FM is far from isolated. Mitchell and Alfuraih (2017) found that over 60% of Saudi English teachers in their study used Arabic language about 30% of the time when teaching English. The use of Arabic was dependent on students' specific needs (Al-Nofaie, 2010) or because it was easier for the teacher (Mitchell and Alfuraih, 2017). The data in the present study revealed inconsistences between the language of instruction and the pedagogies used in public schools and PMU. Consequently, students must adapt to studying in English and in a student centre learning environment in university. However, this may be stressful for some, as identified in the UK (Burke and Crozier, 2014), and can impede academic progress, especially during the transitioning period (Coertjens *et al.*, 2017). Student narratives in the current study reveal that some were ill-prepared for the transition (Al-Saraj, 2014). For some FYS, their limited acquisition of English language skills reduced their ability to succeed in their STEM courses in PMU, resulting in them re-evaluating how they would achieve their aspirations: "I liked high school and my grades were good, but now it is hard at university. I take my grades more seriously because there is a lot of competition" (Maram-FYS). Despite the challenges, they persevered with their studies to fulfil both their self and socio-cultural expectancies, to achieve a degree, thereby reproducing the social structure. This is discussed further in chapter 5.2.1.

4.6 Cultural trends

Traditionally, Saudi Arabian citizens upheld the view that education would make women more cultured, and better homemakers and mothers (Aguirre *et al.*, 2012; Bowden and Mummery, 2014), resembling a view held by Wollstonecraft, in the Victorian-era (Wollstonecraft and Pennell, 1892). However, Hafiz (1990) found that Saudi women perceived higher education

as a route to unlock themselves out of the traditional roles of daughter, wife, and mother, whilst men viewed it as prestigious or a stepping stone for better job prospects. Evidence from this study supports the findings of Hafiz (1990): “Girls think about studies more than boys. If they didn't go to university, they would stay at home” (Lama -TYS). The agentic actions of the girls in this study demonstrated their free will to reject structural inequalities, one of which is achieving a degree without pursuing a career.

More recently, Al-bakr *et al.* (2017) revealed that more than half of the male and female university students, surveyed in Saudi Arabia, believe that Saudi girls wasted their education by not going into a profession. This turnabout in male perspectives is a growing trend (see Omair (2012) and ILO (2017)) and lends support to the women who aim to step on the employment ladder. As mentioned previously, a *Mahram* can support or prevent women from seeking employment, therefore the greater implication is that as male opinions on this issue change in favour of women, it will impact on their attitudes towards their female family members, such that they envision a career beyond studying. Furthermore, it is likely to influence the more reluctant *Mahram,* who according to Alseghayer (2015), would eventually succumb to following public opinion as the rules change, presenting a new structural norm (Giddens, 1984).

Professions have varying degrees of acceptability in different cultures, and this can influence an individual’s choice. Often cultural norms are derived from hegemonic assumptions, and affect individuals’ personal choices, as described by Dooa-TYS:

> Our culture places a rich value in education. Medicine is popular with Saudi girls because of its prestige in society. I wanted to study IT [Information Technology] but I didn’t choose that because it is not as strong as medicine in Saudi Arabia, so I decided to go with medicine.

Throughout this study, prestige has emerged as a recurring justification by participants for pursuing certain careers, signifying that occupational hierarchy is an important structural feature in Saudi society. In a recent study, Sembawa *et al.* (2018) found that Saudi females studying dentistry aspire to fulfil their interest in a successful, professional, highly prestigious and progressive career. Nevertheless, Treiman (2013) argues that occupational prestige is universal and little variation exists between the ranking of the most prestigious professions globally. This is supported by the findings of Musset and Kurekova (2018), and previously by Werfhorst *et al.* (2003), who found that children of the professional classes in the UK chose the prestigious subjects of medicine and law.

Aside from medicine, STEM majors and careers for women is a developing area for Saudi women. The accessibility and uptake of STEM majors by girls and boys in Saudi Arabia generated mixed responses:

> In general, boys and girls are equally encouraged to go into STEM education and careers, but the boys are not excited about higher education because they can get a job without higher education e.g. in the military, but for the girls, it is important, so they stay in higher education (Ahlam-TYS).

There are limited opportunities for girls compared to boys in choice of majors and graduate employment, as Raneem-FYS explains: "Many boys have lots of chances and this is very important for boys, because they have future responsibilities: home, wife and family." Lama-TYS mentioned: "There are probably more women [studying] general sciences, biology, chemistry etc. than men," the quotas for general sciences are much higher than for the most popular majors such as medicine and engineering; subsequently these courses are massively oversubscribed. Thus, without the urgency to work and the limited, although growing, job opportunities, the social structure seemingly perpetuates earlier beliefs that education will make girls better wives and mothers (Hamdan, 2012a). The participants in this study are preparing themselves for a different future, but presently structural reproduction is predominant in families with high educational capital (Bourdieu, 1977), whilst structural transformation is prevalent in families with lower educational capital (Giddens, 1984). Yet, despite increasing education enrolment, there are insufficient STEM-related jobs for women. Thus, external forces constrain their choice to be actively employed, in line with ST (Giddens, 1984).

Parental support and encouragement were earlier found to be crucial in students' decisions to follow the science track in high school. The data also revealed that parents are now perceived as more open-minded than in the past, as Atheer-TYS mentioned: "My family left me to decide [my major] for myself." This was a common recurrence throughout the data. Gina-TYS explained:

> I don't think parents are as critical about their children's major as they were before. Our parents didn't mind any major, but if it was not good for our future, they would say their opinion and suggest changing for a better major."

These narrations appear to refute the perspective that, the main concern is not to appear different from the rest of Saudi Society, (Alseghayer, 2015). Furthermore, Alseghayer (2105) suggests that the lack of independent thinking and formulation of individual viewpoints in the Kingdom are inhibited for cultural or social reasons, preventing people from making their own independent, thoughtful decisions. However, evidence in this study is contrary to this opinion.

Nada-FM eventually fulfilled her fathers' expectation despite contesting his perception of the term 'doctor' by achieving a PhD;

> I remember when I graduated from high school, my dad came to pick me up and said, "You are going to be our doctor". He had made that decision but, I said "no, I'm not going to medical school." He was frustrated and disappointed. I felt so bad, I promised him that I would be a doctor one day, it was not necessary to be a physician.

Nada-FMs agency demonstrated a degree of independence in choosing her major despite the dissatisfaction of her father. Through bargaining and negotiating the rules, she broke barriers within her own family, to deviate from societal expectations and achieved her dream, but this is not always the case (Schimpf *et al*., 2013). The popularity of medicine as a career is reflected in figures 4.3 and 4.5 and suggests that its value and importance is still common. This was reported by the FMs:

> We [Saudi Arabians] have the perception that if you are a good a student or you are smart, you go to medical school, engineering or computer science. So, this perception really pushes a lot of people to go to these specialties.

Students also challenged cultural norms, and made independent decisions that reflect a deeper analysis of their future role in society, including job security:

> I originally wanted to study medicine, but I also wanted a life. It is too much work to study all the time for medicine. I want to enjoy my life as well. I am learning new things all the time, it's really interesting. There are not many people studying statistics, but they need statisticians in the country, so I am likely to get a job when I graduate (Gina-TYS).

In addition, Nora-FM had a similar experience when deciding on her major:

> My first choice was medicine, but I changed my mind to mathematics. Well, basically I knew mathematics and it was the most convenient major for me at that time. Medicine takes a long time and being a female, I think it would not have worked at that time.

Drawing on their prior knowledge about the logistical challenges associated with being female doctors was instrumental in the final decisions made by the Gina-TYS and Nora-FM. They both rejected the societal expectation that they would become medical doctors and used their agency to show that society can be organised differently (transformed) (Giddens, 1984).

As mentioned in chapter 2, previously, the fields of education and training of Saudi women were limited, with science, engineering, and agriculture being reserved for men (AlMunajjed, 2009). Maryam-FM had anticipated changes in the role of women more than 20 years ago.

However, the restricted geographic mobility of women in Saudi Arabia led to her current profession, even though it was not her first choice:

> I was a chemical engineer, but there were no jobs for a woman 20 years ago. Well, there were no jobs in my locality but there was in a well - known international company in another city, so I changed to chemistry. Engineering was new, and I thought the country would change then, but it didn't. Engineering is now available for girls but [still] not chemical engineering.

Some cultural barriers still exist, but these have reduced significantly: "I think the first batch of female graduates would face problems in new STEM majors but after them it should be easier, because its new and women didn't work in these fields" (Maram-FYS); "I think that if the girls want to do it they can and they won't find any problems from society or community" (Jumana-FYS).

Structural barriers do exist but can be attributed to customs in the more conservative families rather than limitations enforced by the authorities. Nawf-FM stated:

> You see, I know that one of my relatives is an engineer, she goes and supervises the buildings and everything. It depends on the tradition of the family. Are you conservative or do you allow your girls to go into that? You don't want her to be facing [male] workers.

Similarly, Amirah-FM pointed out that familial barriers had reduced:

> There are some fathers or brothers who don't want their daughter/sister to work in a mixed environment even today. It is less than before, but I still hear this. Even if their fathers are okay, after they get married their husbands don't want them to have any activities or work with men.

Cultural attitudes take time to change in Saudi Arabia. Al-Bakr *et al.* (2017) claim that a sizeable minority uphold traditional views, such as that a boy's education is more valuable than a girl's. Also, an uneducated man is more powerful than an educated woman because men can express their views publicly but some men frown upon women doing the same. Participants anticipate that society will eventually conform to government mandates and accept that women can work in all fields, especially if women prove that these fields do not breach Islamic etiquettes. Generally, the students in this study acknowledge the cultural context in which their parents grew up and appreciate that issues and challenges still exist. However, they are confident that their experiences will be different, as the structures are susceptible to change.

4.7 Summary and conclusion

This chapter has discussed the four main themes that emerged from the data: personal aspirations, family encouragement, educational experience, and cultural trends. Student aspirations began as early as grade 4-6, and the range of factors that influenced them was greater in the earlier grades than the other educational stages. Medicine was the most aspired towards career, as it holds substantial prestige in Saudi society and the girls want to make a significant contribution to helping others. Thinking about the importance of securing employment, some students used their agency to plan future careers that depart from the most popular majors.

Family educational capital affected student's aspirations and was instrumental in social reproduction. Where mothers were university graduates and employed, girls often aspired towards the same career. Parents with limited educational capital and low socio-economic status provided emotional support and encouragement for their daughters, thereby enabling structural transformation. Fathers, other male family members, and KASP scholars positively influenced the girls and were instrumental in sparking their interests in engineering, through their own lived experiences; experiences that were not conceivable for Saudi women until recently (El-Sherbeeny, 2014). The agency of the male family members contributed to social change for the girls by encouraging them to pursue engineering, for which gender stereotypical viewpoints are still prevalent in Saudi society. Parents' reflexivity brought to light the social conditioning of their daughters (Giddens, 1984; Archer, 1995), whilst in some communities, the socialization of like-minded parents led to collective actions. Using their resources, they jointly planned diverse extracurricular experiences for their daughters, which are not presently embedded in the public schools (Bourdieu, 1977; Giddens, 1979). Currently, government funded STEM initiatives are limited to selected students such as the *Mawhiba* scholars.

Education at all levels is provided by the government, but progression to STEM careers is restricted to the most academic students graduating from the science track (in public schools); the single-route to pursuing STEM education in Saudi Arabian universities. Therefore, as seen in this study, encouraging early interest in STEM education, grades 4-6 is essential for students to consider a future STEM-related career. The political and social structure in Saudi Arabia enables and constrains individual's decisions, as there is a tendency to conform to societal norms. However, those norms are not fixed. They change over time following government mandates and thereafter the agentic actions of individuals or families on a smaller scale until society eventually accepts the new norm.

The chapter that follows moves on to consider students' decisions to pursue STEM majors in university and the career paths they envision for themselves thereafter.

CHAPTER 5
FINDINGS AND ANALYSIS 2

5.1 Introduction

This chapter discusses the findings and analysis of quantitative and qualitative data gathered from foundation year students (FYS), third year students (TYS), and faculty members (FM) in Princess Miya University (PMU). Graduating from the science track in high school earns students the privilege of choosing any foundation programs in the university as discussed in chapter 4. This chapter relates to my second research question (What kinds of STEM-related careers can be available to Saudi girls?). Furthermore, it analyses the data related to its two sub-questions (What factors influence girls to follow careers in STEM? and What is the importance of role models, voluntary work and work placements to motivate girls to enter careers in STEM?).

5.2 Factors that influence girls to follow careers in STEM

Every culture has its own concept of socially appropriate roles for women; western countries support equal opportunities for women, whilst others support roles that may seem discriminatory to people living in the United States and Europe (Syed and Van Buren, 2014). In a global initiative to reduce extreme poverty, the United Nations General Assembly adopted the Millennium Development goals (MDGs), committing member nations to a new global partnership in 2000. Saudi Arabia showed its commitment to achieving the MDGs. However, with respect to the third goal, (gender equality and women's empowerment) Saudi Arabia's focus was confined to increasing women's participation in the labour market (Al-Rushaid, 2010). The 2030 vision reinforces Saudi Arabia's stance, supporting the empowerment of women without committing to western definitions of gender equality:

> With over 50 percent of university graduates being female, the Saudi Arabian government has pledged to continue to develop their talents, invest in their productive capabilities and enable them to strengthen their future, contribute to the development of our society and economy by increasing women's participation in the workforce from 22% to 30% by 2030 (Al-Saud., 2016).

Teaching, medicine, and healthcare professions were the most suitable and realistic careers options for scientifically orientated Saudi women (Hafiz, 1990). Therefore, it is a recent phenomenon that Saudi women are entering a diverse array of STEM-related professions,

including engineering and research (Islam, 2014). The evolving structural changes introduce an urgent need to ensure that students understand the connection between the subjects studied in schools and the newly available careers. Student perceptions of the utility value of a major have a significant impact on their decisions when they choose their undergraduate major, as Nada-FM related;

> In our university we have many majors, chemistry, biology, statistics, mathematics. You won't believe it. Almost no one is into mathematics or statistics, a very limited number of girls. [There are] classes for 8 or 9 students because, then what? [students think] with a mathematics degree I will teach and then what? There are limited options, but in chemistry, biology and biochemistry they have more options later. It's the same for physics, not many girls study physics.

As Amani-FM explains: "When a [student] studies engineering, she will understand where she can work from the beginning; [she will be] combining mathematics and science in problem solving applications." For these perceptions to change, students need exposure to accurate careers information relevant to women in the Saudi Arabian context. In a similar context, students in New Zealand often fail to see the connection between the subjects taught in school and their importance and application to careers (Mills, 2013).

5.2.1 Decision to pursue STEM education at university

The transition between different educational stages, for example, from high school to university, is often contentious (Coertjens *et al.*, 2017). Whilst some students find the transition smooth others encounter difficulties often related to their perceptions of what the transition will entail (Jansen *et al.*, 2012; Rigby, 2017). As mentioned in chapter 4 (see section 4.5.8), students are expected to learn how to use English proficiently and adapt to new methods of teaching and learning once they enter PMU to embark on their foundation year. These are two factors which Saraj (2016) describes as affecting the transitioning of students from Arabic to English medium institutions. Having graduated from high school, students may consider a few different options. Applications for Saudi Arabian public universities commence during the summer vacation after high school graduation. This section analyses why the girls chose to apply to university.

5.2.1.1 Aspirations

Attaining at least a bachelor's degree is highly important for the girls in this study; from their understanding, high school provided the base for their education which would be built on and completed in university. As Toleen-FYS mentioned: "I want to finish my education." Almost

all students gave the same reason, but each expressed their own perception of completing their studies: “When I graduated from high school, I wanted to continue my studies and do a master’s degree, then work” (Lama-TYS); “I continued studying after graduating from high school to complete my studies. Bachelors, Masters and PhD, I haven’t decided yet how far I will go” (Rawan-TYS); “I want to complete my studies by gaining both master’s and PhD qualifications” (Malak-TYS). Irrespective of the level of completion, the overarching message is that a degree is essential. In some cases, the reason was to secure a job, as Rawan-TYS, commented: “Everything here needs a college degree. Maybe I could have worked in a shop or something that didn’t require a college degree if I didn’t join the university.” Maram-FYS stated:

> “I continued studying after high school because it’s important now to get a job, and I like education in general. Now they have a lot of interesting courses; there were only a few choices 10 or 15 years ago.”

Maram-FYS’s viewpoint reflects the structural changes that have occurred in Saudi Arabia regarding the diversification of university majors and the importance of women joining the workforce. For many, the focus was knowledge; “I need it to get knowledge and a good job” (Atheer-TYS); “I went to university because I would get a lot of knowledge” (Shaden-FYS); “Because I love to learn more, I didn’t think about anything else” (Fatima–FYS). Students with early aspirations had specific reasons for joining PMU: “I chose to go to university because I want to study chemistry, I didn’t consider any other options. I wanted to go to university and get my degree” (Abeer-FYS).

Most students did not consider alternatives to going to university and even indicated that there were no other viable options: “I felt that going to university after high school is better for me, I didn't have any other options” (Dana-FYS). Even the few alternatives mentioned were not considered as desirable options: “I could have gone to the British Council [English classes] or worked if I didn’t go to university” (Shaden-FYS); “Maybe I would have done some courses like computing if I didn't join the university” (Rawan-TYS). Raghad-FYS didn’t think about anything other than going to university, as she mentioned that all her school friends are studying at university. However, Nada-FM clarified students’ motives:

> Even if she [the student] is not going to pursue a career, she doesn't want to be less [educated] than others. [The decision to pursue higher education] is now a cultural expectation.

Students mentioned diverse reasons for their choice to enrol in PMU but additionally the underlying social expectation and limited alternatives led to reproduction of current societal norms (Giddens, 1984).

University enrolment is now perceived as a necessity in Saudi Arabia, as recent increases in tertiary education enrolment indicate (OECD, 2017). According to Barnett (2015), upward of 90% of Saudi high school graduates attend university. Yet, despite having one of the highest shares of students graduating from science fields, compared to many other OECD and partner countries (OECD, 2016), the unemployment rate of Saudi women is high. This is indicative of tremendous shifts in cultural norms and expectations, bearing in mind that the first girls' public school in Saudi Arabia opened in 1960, amidst strong opposition from conservative parents (Parveen, 2014).

5.2.1.2 The realities of higher education

Having achieved their goal of joining PMU, this study revealed that for many students their early aspirations and early dreams became less feasible. Attitude towards studying was the issue for Raneem-FYS:

> The subjects at university are very different from school and in Level one, my teacher at university told me I was not good enough to study gynaecology because she thought I wasn't taking my studies seriously because I have a lot of friends and I laugh with them. I won't give up!

FYS faced unexpected challenges, including the academic level of courses compared to high school. Some students like Lina-FYS encountered difficulties in mathematics. She aspired towards a major in physics but changed to chemistry because it is less mathematics intensive. Lina-FYS's reflexivity guided her actions (Archer, 1995), the disparity between mathematics in school and PMU led to changes in her intentions and attitude towards majoring in physics. Nonetheless, she is still aspiring towards a STEM career, but not the one she imagined. Research has shown that in the USA (Anis *et al*., 2016) and in the UK (Devine *et al*., 2012; Cropp, 2017), students experiencing mathematical anxiety may attempt to avoid mathematics. Students in the science track in Saudi Arabia cannot avoid mathematics and for more than half of the participants in this study, it was their favourite subject at high school level. However, this study revealed that, they do not always perform as well in university. Rigby (2017) suggests that the disconnect between mathematics courses in school and university in the UK may be the problem. The resulting difficulty experienced by students in the UK had a potentially limiting effect on self-esteem and performance, leading to their avoidance of mathematical careers (Cropp, 2017). Consequently, irrespective of their aspirations, students

opt for less mathematics-intensive majors once they enter university, as the situation of Raghad-FYS suggests. Mathematics was one of her favourite subjects in high school, and she explains that she was happier in school than in university:

> Science is very difficult, not everything is difficult, just math. I understand every subject in science that's why I wanted to major in it but when I studied in university I decided to change, the math is too difficult. The way we were taught in school is different from university. It means more work for me. If I did do well in math, maybe I would still not continue in science because I thought about business and money. There's no money in sciences, money is important.

Raghad's perspective also indicates that a career in STEM is not the most economically favourable, which is interesting and unlike the views of other FYS in this study. Her knowledge of the potential benefits of careers illustrates Gidden's notion that agents have reasons for their actions and structures influence the actions they can perform (Giddens, 1984).

The criteria for gaining acceptance into the science foundation program are quite stringent; based on high school achievement and national assessment tests. The whole process is executed within weeks and is focused on ensuring students have places. Applications do not require a personal statement, a showcase of accomplishments, or even an explanation of why students want to pursue a major and their future goals. These are immaterial, as currently students must complete the foundation year and achieve the required GPA to be eligible to enter specific colleges. From the students' perspective, acceptance into a university signifies that they possess the necessary academic ability to successfully complete an undergraduate degree. The current study revealed that students rarely had a comprehensive outlook on what undergraduate studies entailed. I discovered that within six months of joining the university, and after consenting to participate in this study, Rana-FYS left the university. She was disadvantaged because of her partial knowledge of the system and consequently left due to her poor academic performance:

> I left the university because of my results; my grades were low. I intend to go back to university next year because I want to study for my future. I like to draw, and I want to enhance my drawings during this year off.

As for Dooa–TYS, she attended a private high school where pedagogical practices were engaging, quite different from those she encountered in PMU. However, the driving force for continuing her education are her own aspirations:

> In high school classes were more interactive, more student driven to get the information. In university, we are just given the information and go. No interaction, but I want to continue my education because I have further goals

> that I want to accomplish. I want to continue in research outside of Saudi Arabia.

Lama-TYS is pleased with the progress made by the university in the two years since she joined it:

> Now my sister is in the first year at university, I think they are doing very well, they also do fun stuff for them. I think the university is doing everything. I am only two years older than my sister, but they are really taking care of the students much better. My mom also studied at the university. She told me that it is very, very, good compared to when she was there. They really improved in just two years.

Clearly, then, the developments over two generations, and even within two years, indicate the efforts made by the university in improving the educational structure and experience of the students.

5.2.2 Career Decisions

High school students wavering about their future careers at the end of compulsory schooling is not unusual in most countries (Musset and Kurekova, 2018), as insufficient or inadequate guidance from career specialists, (Kashefpakdel and Percy, 2017), limited information about types of careers, and the labour market contribute to their indecision. About one in five FYS and one in three TYS in this study graduated from high school without clear aspirations (see figure 4.2).

Nine possible strategies for choosing a university major were presented in the survey undertaken in this study (See Appendix II qu. 7). A closer examination of the FYS responses for each specific strategy, as presented in table 5.1, illustrates its importance in the students' decision-making process.

Table 5.1 Strategies used by FYS to choose a university major

Strategies	Number of students (n)	Students (Percentage)
I discussed career options with my parents	227	74.7
I used websites to find careers that match my personality	200	65.8
I attended talks by women working in STEM to find out about their experiences	156	51.3
I asked my friends to tell me what they thought would be a good career for me	121	39.8
I spoke with STEM teachers in my school to get their opinions about my abilities	93	30.6
I attended information sessions for students at local careers fairs	75	24.7
I discussed career options with my grandparents	45	14.8
I got one or more work placements to observe different jobs	43	14.1
I spoke with the Careers Counsellor in my school	26	8.6

As can be seen in table 5.1 above, the most popular strategy used by students was discussing options with parents, followed by using websites that match careers to personalities, attending talks given by women working in STEM fields, and discussing options with friends. Other strategies were used to varying extents. Bearing in mind the cohesive extended family structure in Saudi Arabia, girls discussing their options with grandparents was less popular than expected. The trend was similar for FYS and TYS with minor differences. FYS were more likely to discuss options with a STEM teacher and attend talks given by women working in STEM than TYS. Work experience and discussing options with a career counsellor were the least employed strategies. Work-based experience is not yet a common practice for high school students in Saudi Arabia, but a few students have access to such opportunities, often through the socialization of family members. The imbalance in access to work experience is one of the aims of the HRDF summer program (HRDF, 2017). Students may not know that the role of the school counsellor in Saudi public schools includes providing career counselling to students, as career education is not taught in schools.

5.2.2.1 Family

Parents and the extended family in general provided encouragement and support for students' career aspirations, as explained in chapter 4 (see section 4.4). The data in this research shows that when deciding on which university major to pursue, approximately 75% of the FYS discussed options with their parents; most often with their mothers, though fathers were also involved. It revealed that the decision-making authority of the student could vary depending on the parents' education capital, as expressed by Waad-TYS:

> The influence on family on the girl's decision depends on the parents' education. If [a] father [studied] for a master's degree in the USA, his [mind set] will be totally different. He will be more open minded which is good. If his daughter wants to study something like engineering, he is going to support her a lot.

The implication of this view is that education abroad can influence views based on observations and experiences that are not common in Saudi Arabia. This holds true based on the KASP scholars' feedback (El-Showk, 2017). In addition, if the socio-economic status of the father is high, then it may affect a student's freedom to choose a career (Rutledge, 2017) as pointed out by Lama-TYS:

> If there is a family business the parents' opinion may affect the student more. For example, if the father was a businessman, he would want his children to run his company in the future, in these cases the parent's opinion is so important. Their child may choose a slightly different major, but, ultimately, they will end up in the family business.

Recent research found that children in Ireland were encouraged to help in the family business (Murphy and Lambrechts, 2015); in this way, their career trajectory was unconsciously being influenced. This implies that students with a lower socio-economic status are likely to have greater freedom to choose a career. Where parents have not experienced a university education, the knowledge about choices of STEM majors and their relative benefits may be partial (Bok, 2010). This can also hold true as in the current study where the available majors for mothers of participants were severely limited. Those who studied STEM-related majors often became science or mathematics teachers or worked in the health services, if they sought employment at all. Of the participants interviewed, 33.3% (10) FYS and 50% (5) TYS were first generation university students; the data revealed that for these students both parents encouraged and supported them in pursuing higher education. Despite their own limited educational background, parents' actions facilitated structural transformation and upward social mobility of their daughters and their family.

The impact of family science capital has been the focus of research (Archer *et al.*, 2012; DeWitt *et al.*, 2016) where it is argued that it can have a direct impact on career choices. Family science-capital would incorporate science-related qualifications of parents, older siblings and extended family members, an understanding about how science works, and knowing people who work in a science-related job. In the UK, research has shown that where parental knowledge of the education system is insufficient, children seek academic advice and support from older siblings (Basit, 2013; Stevenson *et al*., 2017). In this research study, participants' reflections mirrored the same strategy: "My sister is one year older than me, so she was my source of information about careers" (Waad-TYS); "I got my information from my big sister because she also studied in the college of science" (Fatima-TYS). By gaining first-hand knowledge from their siblings, these students had the advantage of a deeper understanding of both careers and university life, compared to their peers.

The effect of culture on motivational processes is often overlooked in Western theories (King and McInerney, 2014), but is undoubtedly important in Saudi Arabia where the medical profession is highly regarded:

> I didn't have enough information about choosing a major, especially in the foundation year we were just taking courses. There wasn't any additional information other than what we know from our culture (Dooa-TYS).

This differs from research in the UK that indicates that science capital was more closely related than cultural capital to science aspirations-related variables such as utility of science, perceived transferability, family influences, and future participation in science (DeWitt *et al.*, 2016). In the Saudi Arabian context, cultural aspects are strong and current, irrespective of family science capital. For many parents, the priority is for their children to become doctors (Baqi *et al.*, 2017) and studying other STEM majors are secondary. As Alseghayer (2015) stresses, it is more about not being different, which contributes to the reproduction of cultural norms (Giddens, 1984).

Parents and students from low SES backgrounds in the UK often have a narrow view of where science can lead (DeWitt and Archer, 2015). Although SES was not measured directly in this study, it was evident that a limited understanding of the advantages of majors, other than medicine, reinforced hegemonic attitudes regarding the most suitable university majors and jobs for girls in Saudi Arabia. As Abeer-FYS stated; "My mum sometimes tries to discourage me. She says chemistry is not good, she would prefer me to study medicine." This is particularly interesting as Abeer–FYS is a first-generation university student. Her mother did not complete high school, but she clearly wants the best profession for her daughter.

Additionally, this study revealed that some parents influenced what they want their daughters to study based on their own experiences and knowledge, as Gina-TYS stated: “Maybe the children will take a major because of their parents. If the father is an engineer and he [would like] his child to be an engineer, the parents’ opinion will affect the child.” This was a view supported by the research findings in Finland, where some children pursue career pathways to please their parents (Ikonen *et al*., 2018) and in the UK (Mellors-Bourne *et al*., 2011). These views illuminate the way in which parents’ limited focus on particular career paths can create tensions between the aspirations of the individual and those of their families (Stevenson *et al.*, 2017). This can have a detrimental effect on the students and their persistence in the major may cease. A few conflicts between parental aspirations and students’ aspirations were reported in this study. Students demonstrated some resilience towards parental preference of majors if they were not comfortable with the choice, for example:

> One student changed from computer science to nursing. She initially chose computer science because her father wanted her to be an engineer. She wants to work in a hospital, but because being doctor demands so much time, she decided to become a nurse. Her father didn't want her to work in a hospital because it’s a mixed environment (Amirah-FM).

In this instance, the student had shown obedience to her father and attempted to fulfil his dream, but eventually she used her agency to seek the help of professors who were successful in convincing her father to allow her to change. This illustrates two important points in this study, as mentioned in chapter 4; first gaining an undergraduate degree is a priority, and second, it is a progressive perspective on women working.

Beyond the family, FYS faced opposing opinions centring on the suitability of specific majors for girls and job prospects. STEM majors are not all viewed in the same light: “Maybe girls wanted to study electrical engineering, but they wouldn’t encourage girls here in Saudi Arabia to do this. There are other majors where boys and girls would be equally encouraged” (Lina-FYS), such as medicine. According to a recent study based on a hospital in Saudi Arabia, doctors believed there was gender equality in most areas, including salaries, benefits and opportunities for promotion; however, it also highlighted a deficiency of women in consultant positions (Baqi *et al.*, 2017). In line with ST, the hospital management enables female employment but constrains their career progression (Giddens, 1979; 1984).

As pointed out by the students in this study, girls are not prevented from studying stereotypically male majors. A more liberal view in decision making indicates that personal choice is a key factor, but, in this study opposing views were noted; “Our society is not ready for girls to be industrial engineers yet, but it depends on the girls themselves” (Waad-TYS);

“Not just here in Saudi Arabia but, I don't think there is a future for girls in careers such as electrical engineering” (Lina-TYS). Still, there is evidence contrary to these students’ perspectives, as, according to Noha-FM, Saudi Arabian female engineering graduates are gaining employment, especially in the private sector (Kinninmont, 2017). Despite the potential barriers, Toleen-FYS believes that women are needed in engineering; “Women have different ideas from men and they need to share these ideas.” Female engineering graduates are using their agency to gain employment in the private sector (Arab News, 2016a) which is the least favourable amongst citizens (Rutledge and Shamsi, 2016; Al-Asfour *et al*., 2017; Rutledge, 2017). Consequently, they are gathering experience, earning an income, and becoming financially independent.

5.2.2.2 Websites

The ease of access to the internet proved to be an effective tool enabling students to research and locate information about careers that suited their personality. Fatima-FYS got information about different careers from websites and from her older sister when she was in high school, but Rawan-TYS was already in the foundation year when she researched about the majors in the university. The internet also serves as a careers library where individuals can search and find information about what different jobs involve. It exposes students to careers that they may never have heard about or considered, or majors that are not available in Saudi Arabia, as Malak-TYS mentioned: “I would have liked to have studied architectural engineering, but because it is not available here, I chose statistics.”

Most websites provide information about careers in a Western context, but the pathway and qualifications are often relevant to those specific countries (Koštálová *et al.*, 2017). In the Saudi Arabian context, the high school leaving certificate (*Tawjihiya*) is not on par with UK’s A level qualifications, although students tend to be the same age. According to UCAS, successful completion of *Tawjihiya* with an overall GPA of 80% or above is equivalent to 5 GCSE passes (UCAS, 2014). Koštálová *et al.* (2017) argue that using the internet to research careers without sufficient guidance can be problematic, and this research study lends support to this claim: “I searched the internet when I wanted information about careers. If I could choose any major, it would be cybersecurity” (Nadia-TYS); “If I could choose any major, it would be mechanical engineering” (Dana-FYS). These majors attracted the students during their internet searches, but they were not available in PMU for girls. Nevertheless, FYS found a great deal of useful careers information on the Internet and this played an important role in helping them to make their decisions.

5.2.2.3 Friends

Previous research has indicated that girls have been both positively influenced towards STEM careers by their friends and in other cases pressured to uphold traditional gender roles (Leaper *et al.*, 2012; Robnett and Leaper, 2013). Students in the current study discussed options with their friends. They anticipated that their close friends would identify or confirm the suitable major or career most suited to them, although those friends may not be sufficiently knowledgeable about careers (Haynes *et al.*, 2013). Ikonen *et al.* (2018) found that girls in Finland discussed career options to the same extent with their parents and friends. Reem-TYS stated "I chose this major because my friend is studying statistics and she loves it," suggesting a high level of trust in her friend's choice and opinion. In other situations, students were discouraged by their peers sometimes based on the perceived difficulty of the majors: "Some of the girls in the university tried to discourage me from choosing computer science; they said that it is too hard" (Rana-FYS); "People tried to discourage me from pursuing biochemistry; they said it's difficult, it's hard, but it's not their choice (Yasmine-TYS). Notably, the narratives revealed that discouragement was not based on gender-stereotypes; instead, they reflect the perceptions or experiences of their friends.

5.2.2.4 Teachers' Advice

Students found a source of reassurance in their teachers. Teachers' positive comments about their academic ability and work ethic enhanced students' self-perceptions and influenced their career decisions. Nora-FM puts forward the view:

> Education is changing a lot and students need to [develop] a very strong personality, to be confident about themselves; what they can and can't do. This will let them choose the correct specialty or education based on what they know and believe is good for them.

The data in this research shows that almost twice as many FYS sought confirmation of their abilities and potential for studying specific majors from their STEM teachers in high school, compared to TYS. Many students were influenced by teachers who were supportive, kind and experienced in their specific subject areas, as previously mentioned in chapter 4.

The education improvement initiatives (Almazroa and Al-Shamrani, 2015) which set out to enrich subject applications and pedagogical strategies in schools by training ICT teachers (Alenezi, 2015) and science teachers in 2014 (Miller, 2014), appear to have enhanced the STEM teachers' abilities to inform FYS about their career suitability. This could account for the differences in FYS and TYS when discussing careers with their STEM teachers. When students speak to teachers about careers, they expect their conversation to be effective in

providing information, guidance, and reassurance. In this research study, one in three FYS aspiring to engineering majors spoke to their STEM teachers regarding their ability to pursue a career in the field. El-Deghaidy *et al.* (2017) found that teachers are knowledgeable about their subject specializations, but need to know more about some STEM subjects especially engineering.

In many countries such as the UK and USA, subject teachers deliver some of the career education in schools (Andrews and Hooley, 2017; Dodd and Hooley, 2018). However, Watermeyer *et al.* (2016) found that while teachers recognized their unique position in providing careers guidance to students, they were concerned that their own limited interactions with and knowledge of higher education, and the STEM industry may be harmful to their students' educational and occupational futures through misinformation. Certainly, in this research, students related how they sought and received information from some STEM teachers and most often, those teachers gave advice based on their specialisation. This emphasizes the need to enhance teachers' knowledge and understanding of careers and the related STEM labour market so that they are better able to support students' career-related learning (Badri *et al.*, 2016).

5.2.3 Priorities in choosing an undergraduate major

Studies have shown that students from affluent backgrounds tend to have high aspirations and choose majors that maintain their social status (Khattab, 2015) such as medicine and law (Werfhorst *et al.*, 2003). However, parents from lower socio-economic backgrounds may view education and careers as routes to upward social mobility (Basit, 2012), especially if they pursue fields like medicine (Basit, 1997; Dimitriadi, 2013). Furthermore, Stevenson *et al.* (2017) discovered that among Muslim families, there is a strong preference for girls, to gain employment that is seen to enhance family honour and reputation, with an emphasis on medicine, dentistry, pharmacy, accountancy, teaching, and law. Lana-TYS explained:

> I think that the community [in Saudi Arabia] pressures boys more than the girls in specific majors e.g. for medicine and engineering. If the boy wants to get married, the father will be proud to say my son is doctor or an engineer. It is also pressure for the girls but not like the boys. A father would also be proud to say my daughter is a doctor, that's why some girls go into medicine. It is a community [societal] thing, medical schools are the best, so if my daughter is a doctor it is the best major.

Dimitriadi (2013) found that in cohesive families, where the viewpoint of the elders is respected and taken into consideration in decision making, there is a more direct impact on career choices than in families that encourage individuality and independent decision-making. In

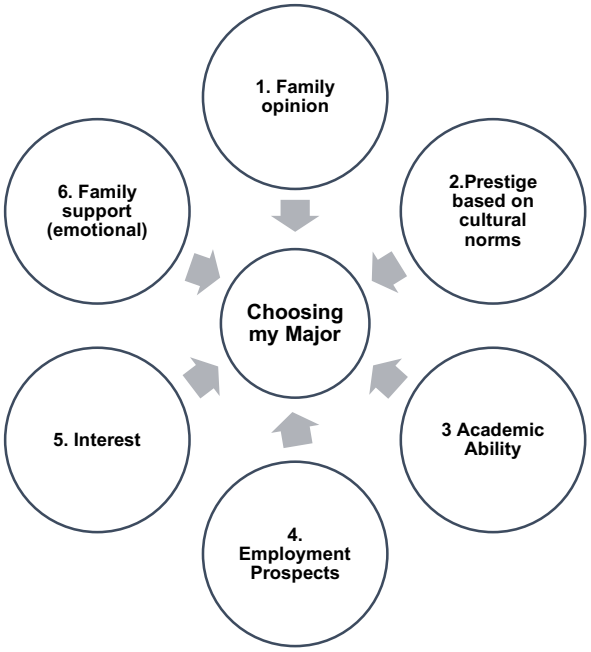
Saudi Arabia, extended family ties have in the past involved joint decision making in important matters, yet the data in this study indicates that a more liberal approach was prevalent in the families of students in this study. The number of FYS (45) who consulted their grandparents was considerably lower than those who had discussions with their parents (227). Generally, the students appeared to have more freedom to choose their career path and participate in the workforce, as Fatima-FYS stated; “My father says industrial engineering is not for girls, but he is still letting me do it.” This supports prior studies concentrating on ethnic minority families that pointed toward a relaxing of previous restricted choices, e.g. Muslim girls in the UK expressed that generally parents would be happy for them to continue in post-compulsory education (Archer, 2002). Additionally, research demonstrates that family pressure to choose better educational and career options was still prevalent (Basit, 2012). Similarly, the Muslim students in the current study tend to consider the utility value of the university major as a precedence rather than selecting a major purely based on interest/enjoyment. Lana-TYS explained that whilst she is passionate about art, her career prospects would be enhanced by pursing a major in statistics. However, the views held by other students varied.

Students were empowered, through recognition of their abilities to pursue a major of their choice and do not readily accept stereotypes that only boys can pursue certain careers:

> Electrical engineering is new here [Saudi Arabia] they need girls to work in many places, so it is important for the girls to study some courses like the boys. Boys and girls are equally encouraged to go into STEM education and careers now, but, before it depended more on the family (Maram-FYS).

In the case of Saudi Arabia, structural restrictions are two-fold: limits imposed by the government and those prevailing in extended families. Few majors were available for women and access to employment was severely restricted in the past; added to that, women were not expected to work outside of the home. The current changes encourage women to participate in working and transforming Saudi Arabia by contributing to the knowledge economy (Bendix, 2017).

Figure 5.1 FYS Priorities in choosing a major



The priorities in choosing a major, as determined from this research study are shown in figure 5.1. Decisions start and end with the family. First, students seek family opinion, and then consider other factors. For some, employment prospects are not significant, but for most in this study they are. Whatever the final decision, they return to family for emotional support.

5.2.4 Careers guidance at school

Saudi Arabia does not have a strong history of career development (Hooley, 2017), and this is clear from the narratives in this study. However, PMU recently introduced a platform that provides FYS with careers information and guidance:

> We have the preparation year and in that year the students have not selected their major[s]. We do target them in the preparation year to inform them about the different departments in the college. The students hear about the departments before joining any department, they are informed about the curriculum and about the [related] careers. Students need to score [a certain GPA] in specific courses to join some departments (Nora-FM).

Whilst this is encouraging for the FYS, it also indicates that students who are seeking employment immediately after graduating from high school, rather than pursuing higher education, have little or no guidance about labour market destinations. As Lama-TYS stated: “My high school should have told me about careers and the types of jobs that are available for us.” In addition, students

are going directly into university without understanding the link between a degree and a career. This was highlighted by Nawf-FM:

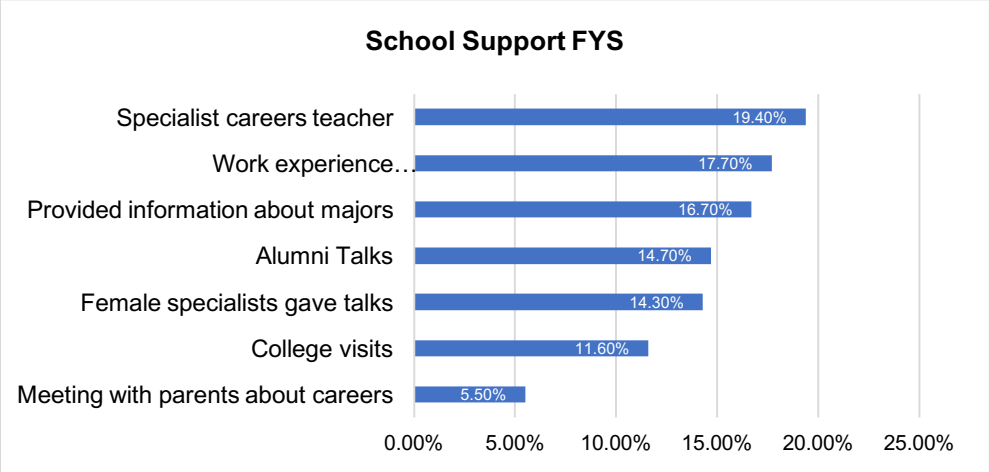
> It is the responsibility of high schools to make sure that students have enough information about careers, more than just a name. They would be in a better position to know what they could do with the different majors. I think career advice should be given on several occasions, starting in high school as a program which continues to the foundation year when they have enough information about the majors.

School aged students need guidance to understand what a career is (Lehmann, 2012; Barnett, 2015). This feeling was expressed by Lama-TYS: “My school didn’t do anything to help prepare the students for university. I heard that other schools [took students] to look around universities, but my school didn’t.” Many students in this study shared the view that careers guidance should start in grade 9 or 10 because in Saudi Arabia students must prepare for the track of education, they want to pursue in grade 11 and 12. They need to know the requirements for certain majors, the grades required in the *Tahsili* and *Qudraa*t exams and someone to direct them. In a few cases, career guidance was integrated into the school’s education plan: “We had career planning classes in grade 10, college planning classes in grade 12 and a college counsellor in school. Our homeroom teachers [class tutors] also [gave us advice] from time to time (Dooa-TYS).” Clearly, in comparison to other students’ accounts, this was a unique situation in a private school, yet one that is necessary to support the students in their quest to discover the most fitting career for themselves.

Many factors need to be taken into consideration if career guidance and education programs are to be implemented in Saudi Arabian schools; introductory grade level, the curriculum and cultural sensitivity of resources, training for career guidance specialist, duration of the program(s) and coordination between the Ministry of Education (MoE), the Ministry of Labour and Social Development (MoLSD), local and national companies and other stakeholders. Efforts to create a career guidance system in Saudi Arabia are in progress (HRDF, 2017), and the expertise of Western consultants has been sought in planning and developing policies. However, there is scepticism about the ability of Saudi Arabia to create a localised, culturally sensitive, comprehensive career guidance model (Hooley, 2017). In the GCC, borrowing educational policies from established systems in the West is common (Wiseman *et al.*, 2017b). This often presents challenges that are more pronounced in the Saudi context because of conflicts between societal norms and the models adopted. Hooley (2017) suggests that the individualistic nature of western career guidance is incompatible with co-authoring of decisions in the Saudi family unit.

The data on high school careers guidance in this research study confirms that this provision is given little attention. Less than one in five FYS reported having a careers specialist in their school and all other indicators were even lower (see figure 5.2).

Figure 5.2 School careers guidance and support for FYS



Careers guidance in some schools was found to be sparse, comprising single-event interventions: “We had one day in grade 12 where they spoke to us about universities and about courses” (Bushra-FYS); “Teachers talked to us about going to university a bit. We had speakers come in to the school on one occasion to speak to us about going to university” (Shaden-FYS). Others did not provide careers guidance at all: “My school didn't do anything to help us to prepare for university (Raghad-FYS); “[My school] didn’t bring speakers or arrange visits to the university, they didn’t do anything” (Juwana-FYS). A few schools provided systematic intervention: “They [the school] taught us how it would be in university, what do we want to do in the future. They did this regularly in grades 11 and 12” (Talia-FYS); “Many people from the university came and spoke to us at school in grade 11 and grade 12 about their subjects and the school helped us with the entrance requirements” (Lina-FYS).

Previously, the criteria for the jobs available to women in Saudi Arabia were common knowledge within the society, and as most women did not pursue a career, career’s guidance in school was not needed, as social reproduction was the norm. However, the recent drive to increase the participation of women in the workforce through Saudization (Al-Asfour and Khan, 2014; Alshanbri *et al.*, 2015) has created a void which needs to be filled, as students need guidance about possible career paths, university majors and employability skills which will enable them to make informed career decisions. Very few parents of FYS had a meeting to discuss careers with their daughters’ schools (see figure 5.2). It is apparent in this study that

home-school relationships are limited and parental involvement in the education of their children is mostly restricted to support from home. Crozier (2016) argues that collaboration between schools and parents in the UK provides better support for their children as the parents would be familiar with the system. It is probable that the parents of participants in this study have not witnessed changes in the system that warrant discussion. Instead, they rely on their knowledge and experience to encourage and support their children, which may not always be current. Thus, further research is necessary to uncover why this relationship is not established.

Based on the evidence in this study, parents are influential in the decision-making process of their children. Therefore, it would be beneficial for schools to develop proactive relationships with parents by holding meetings, making them feel welcome (Crozier and Davies, 2007; Crozier, 2016) and involving them in the dissemination of careers information (Harackiewicz *et al*., 2012) relevant to the Saudi Arabian labour market. In terms of careers education, the data in the current study shows that little has changed in three years, as both the FYS and TYS responses illustrate that less than one in five students received varying degrees of career support from their high schools. The inaction of schools affects the students who have limited access to resources, where, consequently, their career choices reflect mainly structural reproduction (Bourdieu, 1984). However, where support was provided, both reproduction and transformation were evident (Giddens, 1979).

It was found that some public schools are providing limited careers support, but it is not mandatory from the MoE. The schools are required to employ student counsellors, and the responsibilities of the counsellor combine educational, vocational and personal counselling, but guidelines for implementing career counselling programs are not clear (Alghamdi and Riddick, 2011). Thus career counselling in Saudi Arabian schools is fragmented and unstructured (Barnett, 2015). Its implementation and importance depends on the Principal's perception of career counselling and it is, therefore, provided solely at the discretion of the individual schools.

The observed increase in workforce participation and uptake in higher education in Saudi Arabia warrants the need for quality careers guidance to be available for school students. How and where they receive this guidance should be discussed by policymakers according to Hooley *et al.* (2015), but McCarthy & Hooley (2015) argue that this type of discussion is constrained by the challenge of managing collaboration between competing ministries in Saudi Arabia. In the UK, teachers, career guidance professionals and employers are expected to be contributors in delivering career and employability learning (Mann and DiPrete, 2013). Employer engagement in students' careers development is not a new idea in UK schools

(Kashefpakdel and Percy, 2017), but collaboration between schools and employers would be a new phenomenon in Saudi Arabia. If collaboration is envisaged as including periods of work experience, coaxing the more conservative parents may prove to be challenging.

Students in this study were united in their views about the careers provision that schools should deliver. However, their views about when this provision should begin varied from grade 6 to grade 12. Amirah-FM made the following observation:

> I think nowadays education is changing a lot and students need to get a very strong personality to be confident about themselves, what they can and can't do. This will let them choose the correct specialty or education based on what they say, know and believe is good for them. They [schools] should start teaching them in grade 10 because [the courses they study are] general but in grade 11 they are either in the science or literary tracks.

Many students felt that grade 12 would be the most appropriate grade to introduce career guidance: "I think grade 12 is early enough to get information about different careers (Toleen-FYS); I think the school should have given us advice in grade 12 (Sultana-FYS). These views are subjective, as the FYS had already chosen the science track; therefore, career guidance would be directed to realising their prospective career. Waad-TYS, however, had a different perspective: "I think students should be introduced to careers in grade 6 … 12 years old. At this age, they are [competent] in using the internet, they can understand, and they can decide or look for [careers] that they can choose." Here she has taken a much wider approach that would enable students to be acquainted with different career options prior to selecting the track that they want to pursue. Therefore, early exposure to careers information would enhance the students' agency and lead to a diverse range of career aspirations. Thus, reducing the current disproportionate number of students' aspiring to a limited number of majors, and transforming the social norms as outlined in ST (Giddens, 1979). Some students stipulated that careers guidance should include preparation for national assessment tests and be introduced in the 11th grade. According to Lama-TYS, students can take the *Tahsili* and *Qudraat* exams earlier now, in grade 11. Previously, these tests were taken in grade 12 only, therefore earlier guidance and preparation would be advisable.

Schools were felt to be out of touch with the universities. This effectively hampered the student's transition to university. Yasmine-TYS commented:

> There was no information in high school about our life in university. The high schools are not in contact with the universities in Saudi Arabia as much as I think they should be. I think students should be introduced to career options in grade 12. There should be more interaction between the universities and the high schools to prepare the students.

Analysis of the school support provided for FYS by public and private schools showed that in private school students were more likely to have a careers guidance teacher, were given information about different majors, participated in visits to colleges and universities and have talks given by Alumni and female specialists. Clearly, in this study, the distribution and acquisition of career-related information is imbalanced and influenced by the habitus (Bourdieu, 1984). Private schools in Saudi Arabia tend to have an extended school day and have greater autonomy over the curriculum provision, thus enabling additional courses including career/college planning to be offered to the students. This resonates with research in the UK by Moote and Archer (2017), where students in the highest social class tended to report more careers information than their peers from less advantaged backgrounds (Stevenson *et al.*, 2017) and mostly this provision was organised by the school.

In this study, gender-segregated education empowered girls to pursue STEM subjects in school with confidence. Furthermore, this study found that a combination of personal interest, limited choice and cultural attitudes regarding prestige, favour the uptake of scientific subjects and both girls and boys aspire to prestigious professions; medicine or engineering (Treiman, 2013). Although the acronym STEM does not include medicine (Miller and Solberg, 2012), students aspiring to medical careers were included in this study, as medicine is viewed as the most prestigious science-based specialism. Table 5.2 shows the distribution of university majors that FYS aspired to:

Table 5.2 Intended Majors of FYS

Major	**Frequency** (n)	**Percentage** (%)
Medicine	98	31.4
Engineering	47	15.1
Practical Sciences	20	6.4
Pharmacy	15	4.8
Computer & IT	15	4.8
Dentistry	14	4.5
Nutrition	11	3.5
Chemistry	11	3.5
Biology	10	3.2
Physics	7	2.2
Mathematics	7	2.2
Biochemistry	5	1.6
Undecided	52	16.7
Total	312	100.0

The data in Table 5.2 shows overwhelmingly that 31.4% (98) FYS aspire to study medicine. A recent study by OECD revealed that girls often focus on a narrow range of careers such as medicine and teaching and 30% of students in 72 countries aspire to ten professions with medicine being the most popular (Musset and Kurekova, 2018). Ensuring that students are provided with careers education and relevant literature related to a variety of majors is shared with their parents can help to reduce this imbalance by encouraging familial dialogue about other careers (Harackiewicz *et al*., 2012; Svoboda *et al*., 2016; Rozek *et al*., 2017).

5.2.5 Effective school supports

When students were making decisions about which major to pursue in PMU, they used many strategies, and utilised any support provided by their schools. The extent to which these were useful in influencing decisions varied across majors. Tables 5.3 and 5.4 identify which strategies (agency) students adopted when considering specific career options (Tomlinson *et al.*, 2013). The five most popular majors in this study - medicine, engineering, practical science, computing and pharmacy (see table 5.3) - were compared to discern any specific patterns that may be pertinent for selecting each major. For this comparison, data collected from students who attended public high schools was used, n=278. The aim was to identify influences and school supports that were most effective for specific majors. Furthermore, the total number of 32 private school students was too low to make meaningful comparisons, as the number of students aspiring to these five majors ranged from 0 to 16.

Table 5.3 Usage of available school careers support by FYS

School supports	**Medicine** Total n=81 (n)	**Engineering** Total n=43 (n)	**Practical Science** Total n=20 (n)	**Computing & IT** Total n= 12 (n)	**Pharmacy** Total n=15 (n)
My school had a careers guidance teacher	45.7% (37)	55.8% (24)	52.6% (10)	58.3% (7)	46.7% (7)
My school held meetings with parents and students about careers	7.4(6)	14.0(6)	0.0	16.7(2)	20.0% (3)
My school hosted visits from female specialists to give talks to students	34.6% (28)	44.2% (19)	52.6% (10)	33.3% (4)	33.3% (5)
My school invited Alumni to give talks	27.2% (22)	37.2% (16)	47.4(9)	58.3 (7)	20.0% (3)

My school provided materials to prepare students for choosing majors	17.3% (14)	41.9% (18)	21.1% (4)	50% (6)	13.3% (2)
My school organize college visits for students	39.5% (32)	51.2% (22)	73.7% (14)	66.7% (8)	33.3% (5)
My school encouraged work placements	48.1% (39)	48.8% (21)	57.9% (11)	66.7% (8)	53.3% (8)

Many schools have a careers counsellor, organized college visits, and hosted talks by female specialist; even fewer invited Alumni to give talks. The current study shows that some high schools encouraged students to find work placements; it should be noted that this was given as helpful advice but was neither arranged by the schools or mandated by the MoE. One reason for this may be that work experience is not a common phenomenon in Saudi schools; faculty members who were also parents of high school students were reluctant for their daughters to approach companies for work experience. Concerns about the immaturity of high school students, safety in an unfamiliar environment, and the benefit of work experience were voiced by Nada-FM:

> I don't know how culturally people would accept or respond to sending their girls for some hours to places alone. If it is a female-only environment, maybe. It's all to do with age. High school students are 16 or 17 years old but by the time they graduate from university they are older and more mature. I like the idea of sending [my daughter] somewhere to learn all these skills but I will be a little conservative about it. We don't trust them completely, not because they are not trustworthy but because they are not mature enough to judge most of the situations yet. When they are 22 years old, they will see the world from a different point of view. They will learn during four or five years in university how to judge situations.

Clearly, then, the idea of work experience whilst students are in high school is left to the discretion of parents and whether they are willing to embrace the idea.

5.2.6 Effective strategies

Table 5.4 Comparison of the influences used by FYS when selecting a major

Influence	**Medicine** Total n=81 (n)	**Engineering** Total n=43 (n)	**Practical Science** Total n=19 (n)	**Computing & IT** Total n=12 (n)	**Pharmacy** Total n=15 (n)
I used websites	59.35% (48)	76.7% (33)	63.2% (12)	66.7% (8)	80.0% (12)
I discussed options with my parents	75.3% (61)	72.1% (31)	73.7% (14)	83.3% (10)	86.7% (13)
I discussed options with my grandparents	18.5% (15)	18.6% (8)	5.3% (1)	8.3% (1)	20.0% (3)
I asked friends to tell me what they thought would be a good career for me	28.4% (23)	37.2% (16)	47.4% (9)	66.7% (8)	46.7% (7)
I spoke with STEM teachers in my school to get their opinions about my abilities	30.9% (25)	32.6% (14)	26.3% (5)	0% (0)	26.7% (4)
I spoke with the career counsellor in my school	6.2% (5)	2.3% (1)	5.3% (1)	8.3% (1)	0.0
I attended local careers fairs	23.5% (19)	32.6% (14)	15.8% (3)	16.7% (2)	33.3% (5)
I attended talks by women working in STEM	46.9% (38)	48.8% (21)	47.4% (9)	33.3% (4)	66.7% (10)
I got work placement(s) to observe different jobs	14.8% (12)	7.0% (3)	5.3% (1)	0.0% (0)	13.2% (2)

The data shows consistently that most students had discussed options with their parents and visited websites to help them to find careers that matched their personality. It appears that students did not seek advice from school related sources when they were confident with the information that they received from other sources, as illustrated by those aspiring to computer/IT majors. Only those aspiring to engineering used websites more than discussing options with their parents. Students discussed medicine and engineering with their grandparents. Choosing to study medicine would be favoured by many grandparents, whilst pursuing an engineering major was far less common for girls and they may seek the informal

approval of grandparents. The knowledge and resources alone are not enough for some girls to pursue their dreams, as their limited power may be enhanced or reduced by structural constraints in the form of extended family endorsement (Giddens, 1984).

FYS aspiring to engineering careers employed most of the strategies, except for speaking to careers counsellors and doing a work placement. Engineering was previously a male-dominated field (Diekman *et al.*, 2010), and it was introduced less than 10 years ago as a major for girls in Saudi Arabian public universities. Thus, the likelihood that female counsellors and teachers would have the background knowledge to adequately advise girls about this field is minimal. Students found that they needed to attend talks by Saudi female engineers to learn about their experiences, as publications regarding the same are limited. Fatima-FYS was reassured about her aspiration to be an engineer when she spoke to a female engineer: "She told me that engineering is great, [though] not easy and I will love it. I was encouraged by speaking to her, but I liked it already.

Many students attended talks by women working in STEM fields, but those who aspired towards a career in pharmacy, utilised careers websites where careers are recommended based on personal interests and personality traits. In general, talks were beneficial across all fields as they presented useful insights, sparked students' interest, and led them to research about careers using websites. Lina-FYS recalled: "I listened to female lecturers from the university, it was a good atmosphere, they told us about the programs and how to study." Students felt encouraged after communicating with the women who were working in STEM fields or studying STEM majors. During these talks, both the difficulties and the positive aspects of the courses were mentioned so that students received realistic perspectives about the courses and prospective jobs. Waad-TYS stated:

> I think the teenagers these days are familiar with other people's experience. I think they are luckier than me; I really had no idea what I wanted to study before I joined the university.

Students in this study rarely spoke to the counsellors about their careers. This raises questions regarding the nature of counsellors' responsibilities to guide students' career decisions and the importance afforded to this type of support by school principals (Alghamdi and Riddick, 2011; Andrews and Hooley, 2017). The degree to which the strategies were used by students when selecting the top five majors were not significantly different, from each other or other majors (see table 5.4). Students used their agency to obtain information about careers where it was not readily available in school. They all engaged in discussions with parents or used websites the most, and many attended talks by women working in STEM fields. Thus, the

careers support system in schools needs to be developed to meet the needs of the students who are keen to contribute to the 2030 Vision.

5.2.7 Career Guidance at university

PMU arranges a careers symposium for foundation year students at the beginning of the academic year. This is the only opportunity for FYS to attend a gathering where comprehensive information about all majors and their course requirement is offered at PMU. Speakers including professors share their expertise, explaining how majors translate into real jobs: “When we just started in the foundation year, the university held an event about careers and courses” (Noor-FYS); “they talked to us about the different majors.” (Dana-FYS).

This study indicates that exposure to quality careers information positively impacts upon students’ ability to make informed decisions (Hooley *et al.*, 2015), as Bushra-FYS stated:

> I wasn’t sure until after the meeting [the careers symposium] that I wanted to be an engineer. Before, I thought about being a doctor, but I changed when I knew more about this major.

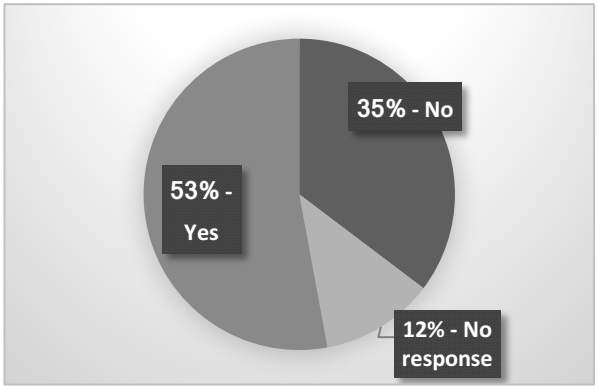
It is evident that the careers symposium had a positive impact on students’ perceptions and on the enrolment of students in less popular majors:

> In my first year, physics wasn't a popular major, but now there are a lot of students. There is more information and explanation about what physics is and the kinds of jobs we can get if we study it, not like when I started (Ghufran-TYS).

This illustrates that PMU is successfully imparting valuable careers information to the students. FYS found that receiving this information directly from the faculty and alumni was more constructive as they were exposed to the realities of the majors and the careers related to them.

The system of allocation of students to majors is based on the achievement of the entrance requirement; (GPA) for the selected major, as illustrated by FYS; “I want to study Electrical Engineering, but I am worried about my GPA, it’s 4.9/5.0” (Toleen-FYS). FYS were making realistic contingency plans if quotas for the most popular majors were filled or entrance criteria were not achieved, as Raneem-FYS stated: “I want to study biology or gynaecology [medicine] depending on my grade. If I have a high grade at the end of year, I can go to medicine but if I have a low grade I will study biology.” FMs explained that with the large and increasing enrolment of students in the university, less than 5% of FYS across PMU eventually achieve their dream and enter their first choice major.

Figure 5.3 TYS studying their intended major



The data revealed that, by the third year in PMU, 53% (16) TYS in this study were pursuing their intended major (See figure 5.3), and at least 35% (10) TYS changed their intended major due to inadequate GPA scores or other factors. Their dreams from the foundation year are long forgotten and they follow another major in preference to dropping out of university. As Maryam-FM stated: “Some of the students enter the university wanting to study chemistry and others just end up on the course.” As majors like chemistry and biology are largely oversubscribed, students need to secure a competitive edge over their peers, if they intend to work after graduation. Structural reproduction persists in the university stemming from the limited number of STEM-related majors, but some transformation occurs when new disciplines are offered.

Saudization is systematically reducing the dependency on foreign workers in Saudi Arabia and providing jobs for Saudi citizens (Shalhoub, 2017). There has been a surge in the integration of women into the workforce in certain sectors such as retail, and factory work. Strategically there is no specific mention of women entering engineering fields, although they are working as engineers, public discourse is intentionally avoided to maintain peace with the conservative members of Saudi society (El-Sherbeeny, 2014). PMU offers two disciplines in engineering; Electrical and Computer Engineering (ECE) and Industrial engineering; following their own market research, they concluded that these were the most preferable fields for females. Interestingly, Saudization is not a solution for women gaining employment in engineering since this choice did not previously exist in Saudi Arabia for female workers in the public sector. This suggests that jobs have been and continue to be created to accommodate the growing number of female engineers (Arab News, 2016a). However, Maryam-FM pointed out that, although there are largely insufficient STEM-related jobs for women in Saudi Arabia,

studying STEM majors can be a foundation for other careers. Yet, this presented a problem in the USA, as STEM graduates pursuing other careers led to a loss of talent from the STEM pool (Mellors-Bourne *et al*., 2011).

5.3 The Importance of Role Models and Extra Credentials

5.3.1 Role Models

Students are more likely to enter a profession when they can identify a role model in that profession (Buck *et al.*, 2008). The support, information, and encouragement that FYS and TYS received from women working in STEM boosted their interest, increased their knowledge about some STEM careers and consequently strengthened their desire to pursue new courses such as industrial engineering. Students do not typically encounter gendered stereotypes often linked with STEM subjects from within these educational institutions, which are gender-segregated. Therefore, they are free to pursue degrees of their choice, subject to availability in PMU.

It is a characteristic of daily life for girls to encounter some women emulating the roles or fields that they hope to pursue; this is a positive consequence of single-sex education for girls (Booth and Nolen, 2012). Women already pursuing science-related careers were viewed as science career role models. Nawf-FM explained why she considered herself a role model for both her siblings and her daughter who is currently in grade 12:

> Maybe because I am the eldest in my family; the eldest sister is like a mother, so I liked teaching [my siblings]. No one forced me. I was first in my division [class in university] so I had the opportunity to choose whatever [major] I wanted, medicine or dentistry. I encouraged my daughter to also follow dentistry. I will tell you something: all my brothers and sisters became dentists after me. I like [Dentistry] and I influenced them. I like my career, and I want to give everyone a positive impression about my speciality.

Similarly, Malak-TYS is keen to promote her major, statistics and expresses the importance of being a role model: “I need to work hard and be a good role model for other girls because I am studying a major, statistics, which is not popular at all, but is needed in our society.”

Despite the absence of any formal structured student career mentoring policies in schools, students are learning from those in their consistent environments highlighting the importance of the social environment for learning (Vygotsky, 1980). Students subconsciously absorb information, mannerisms, and behaviour patterns from routinized practices of the women that are part of their female only spaces. This leads to a reproduction of structures as was evident

when choosing potential careers, but it also provides a supportive system in which women can use their agency to explore new ideas.

Dooa-TYS is a member of a student-led organization in PMU where TYS actively engaged with FYS through mentoring, and provided support and guidance based on their own experiences in the first-year. She explained:

> There is a group organised by the students and approved by the university where we talk to the younger students and support them. They have our telephone numbers and can contact us if they need to, like a big sister programme. This is within the medical college, student to student.

Such mentoring programs have proven to be beneficial for most students in the initial stages of starting university, and the consequent support and reassurance were associated with retention rates in the UK (Collings *et al.*, 2016), and in the USA (Dennehy and Dasgupta, 2017). These mentoring programs are often organised by the universities or colleges. Mentees benefit from their mentors' greater institutional capital, and gain confidence as students who feel that they belong to the university environment (Power and Hibbert, 2016). In this study, the mentoring program was initiated by a group of TYS studying medicine. They used their agency to introduce mentoring in PMU to support FYS in pursuing their dreams of becoming doctors. Through this program, the mentors enabled FYS to understand the structural processes, based on their own experiences and ease their transition into PMU.

5.3.2 Extra credentials – Work experience and voluntary work

Due to the competitive nature of the job market, university students need to enhance their career credentials to succeed in securing their chosen job:

> In my opinion the kind of skills students should add to their CV are; a language other than Arabic, at least English. Wherever you go they ask about your second language, computer skills, at least the basics, and personality, how you communicate with others" (Nada-FM).

Additionally, Kay Carberry argues, "It is more important than ever that young people are able to show personal adaptability and resilience" (Carberry *et al.*, 2015:7). Work experience paid, or voluntary, is viewed as a positive indication of efficiency. According to Amirah-FM, the final year undergraduate students are most academically prepared to benefit from the practical training gained in work experience.

PMU aims to develop employability and broaden career choices in students by enforcing work placements as a graduation requirement and encouraging them to do voluntary work: "We

encourage students to work and volunteer during their studies, it is compulsory to do work experience, summer training in Saudi Arabia or they can do it internationally" (Amirah-FM); "so they are in contact with the market before graduating" (Nora-FM). Experience in the field, addresses the earlier research findings that Saudi women recognised the misalignment between their educational attainment and employers' needs, rendering them ill-prepared for the workforce (Parveen, 2014). It came to light during this study that when work experience was initially introduced to students at PMU, they obtained placements unrelated to the major they were studying to simply fulfil the graduation requirement. Amirah-FM recalls: "The administration, rectified this situation by specifying that the job must be related [to the major] and we contact the company with the criteria." Thus, the university changed the system for work placements so that students would engage in STEM-degree related workplace experiences (Mellors-Bourne *et al*., 2011).

It is quite common globally for students to carry out voluntary work as a form of social responsibility, either individually or as part of established organisations. Philanthropy is synonymous with Saudi culture; thus, this type of voluntary work is supported by families even for high school students. TYS recognise that they must have additional skills and experiences to gain employment, which Lehmann (2012) refers to as 'extra credentials', especially in STEM fields, where a real shortage of jobs currently exists:

> These days girls are not staying home like before. I know girls that are going to work and just volunteering in some office or some clinics. They are volunteering so that they can show themselves [their skills] and improve themselves [gain experience] (Waad-TYS).

The girls, as narrated by Waad-TYS, used they agency to seek voluntary work as an investment that they anticipate will subsequently help them obtain paid work.

5.4 Saudi Arabian women and employment

5.4.1 Employment prospects

With the uncertainty of being accepted into their preferred major, most FYS were too focused on achieving the required GPA to contemplate exploring employment prospects: "There are jobs, but I didn't really consider them yet. There is a very good [multinational company] where girls can work" (Sama-FYS). Others are still researching the applications of the major they are interested in: "I don't know what types of jobs are available for STEM graduates, its new for girls" (Maram-FYS). Even TYS who are currently studying a major, have not planned their

career paths. Lama-TYS stated that she didn't think about where she will work after graduation, but she wanted to use her physics degree, possibly specialising and working in a hospital.

Concerns about the Saudi labour market and graduate unemployment were shared by many students: "There are a lot of girls who have graduated, and they didn't find work. In every company or organisation there is only a limited number of girls working there" (Nadia-TYS). Atheer-TYS also mentioned the shortage of jobs for women, but was optimistic that by the time she graduates, there will be more: "The shortage of jobs is the main barrier to students joining the workforce, that's why we think a bachelor's degree is not enough". This issue has perpetuated over time, as Nada-FM recalled when asked about barriers she faced in her career:

> The only barrier that I faced was being here [In Saudi Arabia]. After [completing] a master's degree, there was no [opportunity to pursue a] PhD and I couldn't work, there were no jobs at all. Now, if [students] are in science fields they may find jobs in hospitals, research centres, and some companies like pharmacies, drug companies, and cosmetic companies.

Generally, jobs in the public sector are favoured as jobs in private sector have shortcomings that graduates find unattractive (Marmenout and Lirio, 2014; Shalhoub, 2017). For some participants, finding employment after graduating from PMU is not a priority: "Maybe I am not planning to work after graduation" (Raghad-FYS). Raghad's comment supports the findings in the Women at Work Trends 2016 Report, which states that the percentage of employed Saudi women is 16%, with the percentage actively seeking employment being 21%; the majority are not looking for work (ILO, 2016).

5.4.2 Workplace realities

Saudi Arabia is an emerging knowledge economy, and it recently announced its 2030 Vision; students envisage their future roles in line with the vision: "I will work hard to build my CV and get a good job to help my country" (Toleen-FYS); "we need to work hard to help achieve the 2030 Vision" (Malak-TYS); "Technology and industry is very important in the world and I want to contribute towards that" (Atheer-TYS). The 2030 Vision has given Saudi women hope, as Nadia-TYS stated: "My generation wants more [a better future], so by seeing the plans for the 2030 Vision, we will work hard to achieve that." Saudi Arabia has increased its drive to help women enter the Kingdom's workforce, but the role of women in science and technology has received

far less attention than other industries such as retail and business. This discrepancy was addressed recently by Dr. Hayat Sindi[11]:

> Indeed, a lot is being done in Saudi Arabia to empower women. Over the coming few years, it is crucial that we continue to take positive action to increase women's role in major industries such as science and technology. This can be achieved through making careers in these industries more accessible and attractive to women (Arab News, 2018:1).

Currently, some STEM graduates are working in non-STEM fields, mainly because of the limited opportunities, whilst many remain unemployed. Ahlam-TYS believes that the workforce is ready for girls, but more jobs need to be available. Not all women are actively seeking employment, but now they have a greater freedom to choose, which is a major accomplishment enabled by the government. Most students in this study expect to contribute to the economy by joining the workforce. Some are aspiring to work in familiar environments; schools and universities where they have ontological security and are comfortable in their female-only spaces. Teaching is viewed as a good career for women and many students expressed that they intend to become teachers in schools or in a university: "The university supports women to get a very good career" (Nora-FM). "When I finish studying, I will teach other students about biochemistry. I plan to study [for a] master's [degree] and PhD so that I can teach in the university" (Yasmine-TYS).

Others will work in establishments where the mixing of genders is necessary for providing healthcare e.g. hospitals (van Geel, 2016). There is, however, a growing number of students who will enter an unknown territory; the male workplace. Since education is delivered in an idealized "women's only setting", work place realities that may include men are unfamiliar to Saudi women (Profanter *et al.*, 2010). Making provisions suitable for women in workplaces has presented companies with problems. For the first women pioneers in most male-dominated companies, their determination to succeed and the foresight of their male managers paved the way for those who would follow their lead (Khoja, 2016). Accommodating women in the workforce triggered structural adjustments for men and not all men were accepting; women were viewed as intruders and had to be slowly integrated into the previously male-only spaces. Thus, over time, the social norm has and continues to be modified in some companies, the agency of supportive male employers is enabling structures to be transformed.

[11] Dr Hayat Sindi, is a medical scientist and was one of the first female members of the consultative assembly of Saudi Arabia.

On the other hand, unsuitable work environments and a lack of transportation top the list of factors that impede female employment (Arab News, 2016b).

The current university students in PMU are in an advantageous position, as the implementation of mandatory work experience prior to graduation enables them to see first-hand the reality of participating in the Saudi labour workforce. The Saudi labour laws exhibit gender equality, with respect to certain rights; for example, women and men are paid equally for the same roles in the public sector. But the labour laws also illustrate that the welfare of women is embedded in society. Notably, regulations prevent women, Muslim and non-Muslim, from working in 23 professions, because such jobs do not suit the nature of women and women are not allowed to work night shifts (MoLSD, 2017). In this way, the labour laws, not only protect women from hazardous roles, but also ensure that family responsibilities remain the priority.

Geographic mobility and flexible working hours are two of the challenges that female STEM graduates may face when seeking employment. Toleen-FYS pointed out that "sometimes women may be asked to work in a different city which is not always acceptable to the family." Social norms may dictate that moving to another city, (without a *Mahram*), where multinational companies employ women, is not generally acceptable but depends on the view of the family. There are other reasons for not leaving the city of birth, such as, a sense of duty to parents (Khoja, 2016). Though these social and structural constraints may prevent women from accepting jobs outside of their home towns, more liberal families are enabling greater flexibility for their women to choose where to live and work in the future. For Malak-TYS, leaving home to pursue a career is her hope, "I want to complete my studies and go abroad. I don't have a specific place, but I am sure I will get a job." She goes on to say, "My mum wants me to work at ARAMCO, I don't know why." ARAMCO is situated in a location that would require Malak-TYS to relocate, thus, in either case she would leave the family home to pursue her career, the latter being prompted by her mother.

PMU have quotas for the more popular and competitive majors, which limits the supply to match the labour market demand, yet the unemployment of female graduates is high (OECD, 2016). FMs mentioned that some members of Saudi society are still opposed to girls studying engineering. For this reason, the introduction of engineering disciplines at PMU and other universities has been gradual, as suggested by El-Sherbeeny (2014), and more engineering disciplines may be introduced in the future guided by Saudi labour and market demand. Nora-FM mentioned that while engineering is a new discipline for women in Saudi Arabia, the labour market can absorb the students smoothly and the girls have proven that they are very capable

engineers. However, as the number of universities offering engineering majors has increased in recent years, there is cause for students to be concerned about job shortages. Many female engineers like to work as lecturers or researchers, but they face difficulty due to the lack of research opportunities and, therefore, some might continue their postgraduate studies abroad.

> Engineering if we compare with medicine requires a lot of interaction between [men and women] and in our country, until now they [society] don't want a lot of interaction with the boys, but the field requires it. Some of my friends are in engineering and they say it is a problem because sometimes they must work together [with boys] on combined projects and [the universities] don't allow them. In the end they go abroad to complete their studies. Some parents would like them to stay here, but there is nowhere to continue [their studies] (Dooa-TYS).

Some Saudi female engineers work in factories or companies, but the country's social environment doesn't accept them undertaking outdoor or strenuous work onsite, despite their capabilities (Al-Asfour *et al.*, 2017). Consequently, many, but not all, Saudi female engineers are working in administrative positions, because of obstacles preventing them from working in outdoor sites (Arab News, 2016a).

5.4.3 Work-life balance

Students in this study intend to adhere to the necessity of a work-life balance within the bounds of Islam and Saudi culture (Sembawa *et al.*, 2018) in pursuing a career. They are familiar with the societal pressure and expectation that led their mothers to prioritise family and home responsibilities over employment (Rajeh *et al.*, 2017) and even education. Research has indicated that changes in the Saudi culture represent a more liberal view on women and work than in the past. It was found that 42% men and 30% women think that women should care for the family, 44% men and 56% women agree that women should do both, and 12% men and 13% women agree that women should just do paid work (ILO, 2017). The inclusion of male responses in the ILO (2017) study was important to understand their stance on the socio-cultural norms. Consequently, a shift from tradition presents a compromise, supporting women working but retaining her duties to take care of the family.

Abele and Spurk (2011) argue that transitions with respect to career development such as job changes and relocation decisions, promotions, periods of unemployment, and becoming a parent have different consequences for men and women. Most TYS anticipate being active in the workforce after completing their studies and have already made conscious decisions regarding their future responsibilities: "If I have other responsibilities, babies. I would stop working to take care of my children" (Lama-TYS); "If I am having a family, I would stop working

because I wouldn't want anyone to raise my children, after that I will continue working" (Dooa-TYS). Not all students agreed with the idea of staying home to raise their children, as Raneem-FYS said: "I don't want to stay at home and look at my babies and my husband, no, I want to work."

In many societies, the predominant model is still that women carry the greater domestic workload, including caring for children (Naz *et al.*, 2017; Hardy *et al.*, 2018). As Naz *et al.* (2017) emphasize, this makes the balance between work and family life especially difficult for women in Pakistan with multiple roles at home and at work. Support from extended family members and Saudi labour laws (MoLSD, 2017) facilitate a balance between home and work. Childcare facilities must be provided at the workplace if the number of women being employed in a company exceeds a specified minimum. Amirah-FM previously worked in industry, but felt that teaching would be easier for the working mother; flexibility of timing was her motivation for joining the university, a view that has been revealed in previous research (Edmunds *et al.*, 2016). Women make sacrifices (use their agency) in order to pursue their careers, with certain structural norms altered in the process, but the women do maintain their obligation to family duties.

Financial responsibility for the family is borne by the husband in Islam (Kounsar, 2017), but there is an underlying concern about the high rate of divorce in Saudi Arabia, particularly among working women, though the reason for divorce is not attributed to the fact that women are working. Similar scenarios are evident in MENA countries, where Qatari women were found to give preference to family, over work and education, fearing divorce and financial instability (James-Hawkins *et al.*, 2017). In the present study, Lina-FYS commented: "I will get my master's [degree] work and not be dependent on anyone." Thus, through economic empowerment, a Saudi woman can bear the burden of her own financial responsibilities if left alone due to divorce or other reasons and would not be considered a burden to her family, as in the past. This represents a significant structural transformation for women, enabled by their increased access to employment and in line with ST (Giddens, 1984).

5.5 Summary and Conclusion

The four main themes identified in this study are personal aspirations, family encouragement, educational experience, and cultural trends. In this chapter, family opinion prestige, utility value, ability, potential employment, interest and family support were important in selecting a major. University education is of utmost importance in Saudi society, expected by parents, desired by girls, and funded by the government. Early aspirations are rarely realised but

achieving a degree is the priority; students understand the value and the benefits they receive in terms of social standing and potential careers.

A range of strategies were employed by students to select the most suitable major to pursue in university, but some were unable to express a deep sense of why they aspired towards a major or career, replying simply that they loved it. Clearly, then, there is a need for students to thoroughly explore majors and the careers they may lead to during high school. The family is central to decision making in Saudi families, but this study highlighted a shift in authority, giving greater freedom of choice to girls in decision making processes. Students used websites extensively, even though they provide minimal information about careers geared towards women in Saudi Arabia. School career guidance was found to be inconsistent across schools, if present at all. Where schools provided information about majors, hosted talks by female specialist and organised college visits, these were beneficial. However, the role of the school counsellor in supporting students with careers counselling was not common knowledge, and, consequently, few students sought their advice.

Individually students use their agency to carve out career paths that will increase their employability, but most retain the view that caring for the family must take precedence over employment. Collectively, they support each other in gently breaking societal barriers, beginning with their families. Saudi women are ready to contribute to building a knowledge economy in line with the 2030 Vision, not to compete or be equal with men, but simply because they have the ability and, now, they have more opportunities.

Chapter 6

Conclusion

6.1 Introduction

This chapter presents the conclusions of this research and highlights its original contribution to knowledge. It states its limitations and offers recommendations for future research. Additionally, I reflect on my experiences, both as a practitioner and a researcher in the Kingdom of Saudi Arabia.

The consensus in government bodies is that science, technology, engineering, and mathematics (STEM) skills are crucial for achieving economic competitiveness. The predicted shortage of highly skilled scientists, technologists, engineers, and mathematicians for future generations has created panic within industry and governments, globally (Smith and Gorard, 2011; Rothwell, 2013). The potential threat to economic production and global competitiveness has elevated the STEM issue to frequent discussion by leaders (Smith, 2010; Beede and Julian, 2011; Bell, 2016). Although Smith (2017) argues that the shortage is based on misinformation, measures to combat this deficiency have targeted groups identified as underrepresented in STEM fields. Amongst these groups are girls and women (DeWitt and Archer, 2015), as mentioned in chapter 2. With gender equality, high on the political agenda, the underrepresentation of girls and women in STEM fields has attracted a tremendous amount of attention. Education at all levels has been subject to scrutiny. Reports indicate that sparking interest is insufficient for girls to choose STEM careers (OFSTED, 2015b), and as Smith (2010) points out, the uptake of STEM subjects and careers has not changed significantly despite an abundance of initiatives to promote STEM. Despite recent research countering the indiscriminate STEM skills shortage claims and highlighting the actual surplus and shortages in specific STEM fields (Smith, 2017a), the drive to achieve gender equality in STEM fields continues. The secular concept of gender equality is complex, and wanting of a universally acceptable definition. Whilst gender equality as prescribed by Islam maintains that women and men are equal but with different roles.

Saudi Arabia is an Islamic country, with a unique social structure, gender-segregated educationally and socially, in the public sphere and converging only within immediate families (van Geel, 2016). In this mixed-methods case study research, I focused on determining the representation of Saudi Arabian women in STEM education and careers. Through sample triangulation of data gathered from foundation year students (FYS), third year students (TYS),

and faculty members (FM), I discovered fluidity in educational and cultural perspectives. Furthermore, through methodological triangulation, I was able to examine the views of a larger number of participants through questionnaires and then focus on in-depth perspectives of a smaller number of students and staff through follow-up interviews. This research addresses the following two key research questions and four secondary questions:

1. Why are STEM-related education and careers important?

    a) What factors influence Saudi Arabian girls' decisions to study STEM subjects?

    b) What makes STEM subjects an appealing choice in Saudi Arabian Schools?

2. What kinds of STEM-related careers can be available to Saudi girls?

    a) What factors influence girls to follow careers in STEM and why?

    b) What is the importance of role models, voluntary work and work placements to motivate girls to enter careers in STEM and why?

This study presents a very rare glimpse into education in Saudi Arabian schools from students' perspectives; describing the basis of their STEM aspirations, and the importance of pursing the science track in high school and STEM majors at university. Meaningful patterns in the types of influencers were identified at different grade levels, providing a solid case for sparking curiosity and nurturing STEM interest from the earliest grades. The main influences on Saudi Arabian girls' decision to study STEM subjects were determined in this study. Furthermore, an exploration of the approaches used by the girls, to facilitate decision-making regarding STEM careers, highlighted the present status of career education in Saudi Arabian public schools. What follows, are recommendations for the enhancement of STEM education in schools, along with a scheme for developing and implementing career education in Saudi Arabia.

6.2 Girls and STEM subjects in Saudi Arabian Schools

In this study, students refer to subjects by their specified names - biology, chemistry, physics, mathematics and technology (computer studies) - as they were not familiar with the term STEM, and engineering is not offered in the public-school curriculum. As mentioned in chapter 4, most students prefer lessons where connections between subjects and real life are exemplified. This was the most significant influence on students' aspirations to follow STEM education. Pedagogical strategies that fostered fun and interactive lessons had a greater

impact on students prior to high school; thereafter, their focus shifted to achieving a high GPA. Nonetheless, mathematics and chemistry were consistently the most enjoyable lessons in high school, whilst computer studies were the least. Teachers' rapport with students, positive feedback on students' abilities, and their passion for their disciplines were contributors in inspiring interest in STEM.

Problem-solving and critical thinking activities were incorporated in the overhauled science, mathematics, and English curriculum for grades 4-12 introduced between 2008 and 2011. One of the key aims of the MoE was to eradicate the practice of rote memorization, which was previously common in Saudi Arabian public schools. Yet, this study revealed that teachers use a diverse range of pedagogies, reflecting old and modern styles (El-Deghaidy *et al.*, 2014); these included lecturing, using textbooks only, rote-memorization, and student-centred and interactive teaching methodologies. Thus, despite the provision of resources for students' education, the system employed in schools can enable or constrain teachers who want to implement diverse pedagogical strategies. On the other hand, there is evidence in this study that individual school teachers, using their agency, employed pedagogical strategies in their subject specialism which were not practised by other teachers in their schools. These teachers refused to accept the norms governing the educational practices embedded in their schools, using their power in line with structuration theory (Giddens, 1979; 1984). The disparities were attributed to a reluctance to change in some schools by management, with a lack of school policies regarding teaching methodologies and teachers with limited or no teacher training. Thus, ontological security, as postulated by Giddens (1991), led to the reproduction of the traditional education system in those schools. Technologies and multimedia resources are used in most schools by some teachers, thereby diversifying the delivery of curriculum content. Where schools engaged students in research projects, students found these memorable. Answering problem solving questions in mathematics was common across schools and students, whilst conducting or watching demonstrations of experiments in sciences, was practised extensively in some schools and not at all in most. This study revealed that in high school, students felt that experiments were exciting but not essential in understanding the course content and achieving high grades. FMs noticed that many FYS were deficient in hands-on practical laboratory skills, which would be a beneficial base for the mandatory laboratory courses in the foundation year.

An analysis of 'favourite and difficult' subjects in high school revealed that mathematics was the most favoured subject, followed by chemistry and biology, then physics. Computer studies was the least favoured, although it was the least difficult subject. It is noteworthy that less than

1% FYS in this study aspired towards a major in mathematics or computer science before graduating from high school compared to medicine (23%) and engineering (9%). Students perceived that a degree in mathematics could only lead to the teaching profession or provide a base for other subjects, thus it was rarely chosen as a preferred major. Computer studies in high school provided a poor foundation for computer courses in university, skills such as basic programming are not taught despite government spending on technology (Alothman and Robertson, 2015). After joining the university and learning about the content of the computer courses, 4.8% FYS aspired towards a major in computer studies, inspired particularly by the programming components. Similarly, a few students pursued a degree in statistics after learning about its utility value.

6.3 Making STEM subjects an appealing choice for Saudi school girls

This study confirmed that because girls and women in Saudi Arabia spend most of their time in female only-spaces, their behaviours and experiences are routinized and fashioned by encounters in these environments. Gendered stereotypes associated with STEM subjects were not evident in this study; in school, mathematics was the favourite subject for most students and all science subjects are mandatory. Students in Saudi Arabia associate sciences with the practical fields that they are exposed to from an early age. At each of the specified educational stages, medicine was the most popular major in this study. This study revealed that, as students progressed through school, they aspired towards an increasingly diverse range of STEM majors as their exposure to knowledge about different fields improved.

Whilst most learning takes place in classroom settings, many students used the internet at home to research information on different topics to satisfy their curiosity. Schools arrange field trips for students at various junctures during the school year, but these trips are viewed as fun days. The notion that field trips can be used as tools to support classroom learning is not common in Saudi Arabia. Furthermore, educational field trips for girls to visit STEM facilities would not be permitted by the MoE, as employees at these organisations are predominantly male. In the light of this, visits to female only STEM facilities should be considered.

This study indicates that, in general, Saudi Arabian public schools do not offer extracurricular STEM outreach activities, but students who are identified as gifted and talented by *Mawhiba* have access to a range of outreach activities and events (see chapter 2). *Mawhiba* focused on enhancing students' skills in STEM fields. The *Mawhiba* scholars can participate in summer science programs and competitions organised in collaboration with a range of local, national, and international establishments. One extracurricular activity that is subscribed to by some

schools is First Lego League (FLL), robotics and invention (Jazzar, 2015). Robotics offers a prospect for integration of engineering and programming into schools (Witherspoon *et al.*, 2016). In schools, engineering is the least developed STEM subject; none of the participants in this study had participated in robotics in school. When robotics is offered in a school, it does not benefit all the students, as it is selective based on students' interest and computer programming skills and involves just enough students to form teams. There are a few alternative routes to access and participate in FLL or summer STEM programs, but these are not subsidized; this limits the participation in STEM outreach to high achievers. It also sends messages about who can be a scientist as found in the UK; "the very clever or high attaining" (DeWitt and Archer, 2015:2186). However, this does not deter girls from following their dreams to pursue STEM education and careers. Some students acquired educational capital through the collective agency of their parents and like-minded friends who created extracurricular activities for them to narrow the gap presented by selective access to STEM initiatives.

As this study shows, students' desire to pursue STEM subjects developed from early experiences in school, inspired by the connections between subjects and everyday life. This is particularly important, as topics become more abstract in higher grades, thus nurturing early STEM interest is imperative. Cultivating interest in STEM must be accompanied with academic support prior to grade 11, when students continue with or exit entirely from STEM education (Adamuti-Trache and Andres, 2008). Public school students must graduate from the science track to pursue STEM majors in Saudi Arabian public universities. Furthermore, developing students' skills in performing practical experiments and field work would add a new dimension to lessons, which most students in this study enjoyed or yearned for in school.

Students largely pursue STEM subjects for their utility value, a prerequisite for majors leading to careers where they can help other people (Su and Rounds, 2015). Qualified and passionate teachers, who engage students in subject related hands-on activities and experiments foster positive attitudes towards STEM subjects. Failure in high school is not an option and students overcome academic challenges in school through hard work and perseverance, with the help of supportive teachers. Interestingly, students' agency often resulted in a structural transformation; they developed a passion for the subject(s) they had regarded as problematic (Giddens, 1979:1984).

The standardised curricula provided to Saudi public schools are taught in Arabic, whilst many Saudi private schools employ both Arabic and English instruction, often with sciences and mathematics being reinforced in English using books and resources from Western publishers.

Hence, private school graduates tend to be better prepared, linguistically, and are more familiar with scientific terminology than public school graduates. Consequently, the former group has a higher propensity for achieving a high GPA at the beginning of the foundation year. Evidence also indicates that some students took steps to increase their English language skills independently of the curriculum offerings, thus enhancing their likelihood to succeed in the foundation year.

Students' transition from high school to university was affected by unfamiliar institutional practices; pedagogical strategies which promote student-centred learning and switching the language of instruction in all STEM courses to English. The English Language program offered in the foundation year aims to raise a student's skills to B1+ level on the Common European Framework of Reference for Languages (CEFR) (Council of Europe, 2018), which corresponds to an intermediate level of English (UCLES, 2018). Successful completion of all English and core courses in sciences and mathematics is required for progression to the second year. This raises questions, as the core courses require a higher level of English comprehension than the English program aims for, as is presented in the relevant science and mathematics course materials. This study revealed that, for several students, their achievement in the first semester of university was lower than they expected considering their higher GPAs in school. This led to self-doubt and resulted in changes to preferred majors, during or at the end of the foundation year. Students rarely drop-out of university as gaining a degree is important for maintaining the *status quo* (Alseghayer, 2015), or elevating social status, and increasing employability. Thus, students' actions reproduce the structure that is already in place, but also increases their own capabilities (Giddens, 1979;1984). Where aspirational changes occurred, almost all students intended to pursue another STEM major, depending on their GPA scores at the end of the second year.

6.4 The influences on girls' decisions to pursue STEM-related careers

The university has two broad choices of foundation year pathways: 1) Sciences or 2) Business and Arts. Students who graduate from the science track in high school and achieve the required scores on the national assessment tests can apply for either of the foundation year pathways. There is a societal and familial assumption that science track students, with a high GPA at the end of grade 12, will pursue a career in medicine. In this study, there are cases from FYS, TYS, and FM who conformed to this expectation, but others who used their agency to challenge this assumption and pursued other majors, and those who followed their own dream to pursue medicine, not because they were expected to.

Career education in schools was generally found to be sparse, ranging from no provision to one-off interventions to regularly planned provisions. It varied considerably, from one-day events at the end of grade 12, to more regular events between grades 10 and 12. Students in this study generally expressed a preference for guidance to start in grade 10 or even earlier to allow students ample time to make purposeful decisions regarding which high school track to pursue. All Saudi Arabian schools have school counsellors but allocation of their time to career guidance and counselling is left to the discretion of the school principal. Very few students spoke to the school counsellor about careers, compared to those who consulted their STEM teachers.

When making decisions about the major to pursue in university, most students consulted their parents, yet public schools failed to discuss the future career plans of girls with their mothers, as there were never any parent-teacher meetings related to careers. Dimitriadi (2013) argues that in countries where the family unit is influential in career decisions, parents must be brought in and educated on the possibilities available. Students attended talks by women working in STEM; they found them beneficial and thereafter accumulated information from other sources including websites, family members, friends, and teachers in school or in the university. Websites provide an accessible source of information; however, the available careers information bears little relevance to the Saudi Arabian context, as information is from the West, with limited information, where it exists, on Arabic websites (Koštálová *et al.*, 2017). STEM teachers, who demonstrated a passion for their field, and who inspired students to pursue their major, were often unable to advise them about other careers. Family members and friends drew on their own experiences when advising the girls and this sometimes affected the girls' choice of a major.

This study showed a growth in the diversity of majors that students aspired to between grades 4 and 12 in school, as their exposure and knowledge about different fields increased. In grades 10–12, engineering as a career became significant for the FYS participants in this study, coinciding with the graduation of the first batch of female engineers in Saudi Arabia; a substantial landmark for Saudi women in STEM education. Afterwards, male family members have been instrumental in encouraging girls to pursue engineering disciplines, but there are people in Saudi society who are still reluctant to accept women working in this profession.

The dearth of careers guidance and support in schools led to the need for the university to organise a careers symposium at the beginning of each academic year for FYS. This was found to be highly beneficial, with students learning about majors offered in PMU and their utility values in Saudi Arabia, since this information was conveyed by subject specialists and

current university students. Student perceptions of some majors, for example, statistics and engineering, were more positive after the symposium. In this university, initiatives are organised individually by some STEM departments for FYS. In addition, the engineering department extended outreach activities to high schools, but this is not common or systematic due to a shortage of student volunteers and the large number of schools. The findings of this study suggest that schools and universities need to collaborate in a systematic manner to support students in their transition from schools to universities. For example, students felt that schools could not guide or advise them adequately on what to expect at university, reiterating a point implied by university administrators (Abdul-Ghafour, 2010).

This study shows that STEM education and careers are important to Saudi Arabian girls. This importance is in partly based on hegemonic beliefs and patriarchal traditions, which have perpetuated through generations and which are institutionalized; science is for smart people and medicine is the best career, for example (Treiman, 2013). It also stems from the personal desires and aspirations of the students. A relaxation in societal norms is also evident in this study, as the parent-daughter relationship shows a tendency towards authoritative rather than authoritarian. The girls appear to have greater autonomy, and many parents in this study allowed their daughters to choose their career paths after discussing options. Thus, by parents supporting their daughters' capacity to choose a major they enable structural transformation (Giddens, 1979, 1984; Rutledge, 2017). This autonomy, although emancipating, will prove to be short-lived, save for approximately 5% of all foundation year students at the university. The seats allocated to specific colleges in the second year are dependent on students' cumulative GPA at the end of the first year. The required GPA for each major is variable and quotas for each major are applied. The cumulative GPA carries more weight than students' aspirations and intentions. With the massive enrolment of Saudi girls in higher education, only around 5% of all FYS achieve their dream. The remaining 95% choose or are encouraged to accept places on alternative STEM majors. This study illustrates that obtaining a bachelor's degree is more important than the major studied, hence students remain in the university after choosing another major and complete STEM degrees that are not usually their first choice. With effective career guidance, students can be better positioned to choose from the broad range of majors available, rather than concentrating on a few majors that are oversubscribed. Accordingly, aspirations can predict interest in pursuing STEM education, but they cannot predict pursuing a specific STEM major or future STEM employment, as a complex range of factors need to be taken into consideration. Nonetheless, students' agency is enhanced by knowledge about careers, which can enable structural transformation if they intentionally pursue diverse STEM majors. However, in the current study, the dominance of structural

reproduction in the university is a circumstance of the limited number of STEM majors, the ensuing quotas, and high student enrolment.

Saudi Arabian girls enter university to complete their studies, though the level of completion is ambiguous and depends on the individual; bachelor, master's, or PhD. High levels of formal education are perceived as prestigious in Saudi Arabia and the key to securing employment. University education has progressively become an expectation in Saudi society, irrespective of socio-economic status of the family. A massive number of students attend university, facilitated by tuition-free higher education and a monthly stipend for maintenance. Previously, girls pursued a university degree to become more cultured, in preparation for becoming homemakers. Women were not expected to work outside the home, except in the fields that served other women such as the education and welfare of girls, in female only banks, and in healthcare. This is no longer the case, as Saudi Arabia is keen to facilitate the participation of 30% Saudi women in the workforce, according to the 2030 Vision. The inherent philanthropic nature of the Saudis is expressed by the desire and even dream of students to help people and contribute to their society; this was revealed as the most popular reason for pursuing STEM fields and is consistent with previous studies that indicate that girls are likely to follow careers of a people-orientation nature (Su and Rounds, 2015).

This study demonstrated the individual, and at times collective, agency of girls within and beyond their gendered spheres (Le Renard, 2014), and supported Giddens' concept that human agency can make a difference to outcomes. Throughout the study there was a keen sense of purpose from students who acknowledged that the female Saudi pioneers in novel fields such as engineering had paved the way for girls who aspired to enter these fields. Girls envisioned their future selves and despite the uncertainty that their aspirations will be realized, they encouraged each other to strive toward achieving them. They tapped the available resources on the internet to find out about interesting careers, spoke with women in various STEM fields, discussed options with their parents, friends, teachers and extended family members and attended the career symposium at PMU. A few who initially aspired to becoming medical doctors diverted their interest to more pragmatic options: they were those who were equipped with knowledge about STEM-related careers from different sources. This implied a seriousness, which encouraged parents to be more open minded. Some girls used their agency to negotiate familial concerns by gaining support for their aspirations from male family members who then championed their cause in the extended family (Al-Khudair and Pritchett, 2017). Thereafter, they were determined in their resolve to achieve the high level of academic qualifications required for entry into the science track at PMU.

When preferred majors were not offered at PMU, or quotas restricted entry into highly competitive majors, girls persevered with another major as a stepping stone to pursuing postgraduate studies in Saudi Arabia, or abroad where, “A number of multinational companies operating in Saudi Arabia already choose to recruit Saudi students directly from Western universities” (Kinninmont, 2017:38). This study highlights that Saudi girls used their agency to mentor girls younger than themselves. TYS used their own experiences to guide FYS and school-aged girls within their social network. In such instances, TYS gave insights about university life and offered support to FYS during the latter group’s transition into the university. TYS encouraged school-aged girls to use the internet to explore possible careers and to develop their English language skills prior to joining the university. Some of the participants in this study attended career talks given by female specialists in STEM fields especially in the more contentious fields like engineering (El-Sherbeeny, 2014), for which there is minimal information available in the public domain (Arab News, 2018). The 2030 Vision was timely and has impacted on the career decisions of many FYS in this study, since they were not assigned to specific majors at the time of this study. They became acquainted with the aims of the 2030 Vision through their studies at PMU, thereby recognizing and welcoming the fact that they had a role to play in its achievement (Arab News, 2017).

To secure their roles some FYS decided to pursue fields which were identified as areas of expansion in the 2030 Vision, namely technology and statistics, since the sciences and engineering are already oversubscribed in PMU. The girls in this study recognized that in addition to qualifications, enhancing their employability was important. Some took extra courses, participated in community service projects and sought opportunities to introduce initiatives in the university. Furthermore, they acknowledge that the mandatory work placements they will undertake are central to gaining familiarity with the workplace environment and developing the essential skills for their potential jobs. Most significantly, several Saudi Arabian female STEM graduates are willing to pursue private sector jobs (Kinninmont, 2017) averting the structural constraints and competition which hinder entry into some public-sector jobs. Giddens’ conception of human agency affirms that people’s activity matters (Whittington, 2015). The agency of the girls in this study made a difference to their lives and is impacting the wider community. By pursuing increasingly diverse STEM-related majors and aspiring to joining the workforce after graduation, they inspire the younger generation to challenge the predominant hegemonic beliefs embedded in some sectors of their communities.

Currently, the job market in Saudi Arabia is very competitive, with limited jobs in the more favoured public sector. Female graduates are expected to fill positions in the private sector, created through Saudization. Female STEM graduates want to apply the knowledge gained in their majors and prefer to pursue higher academic qualifications rather than work outside their field. Teaching is still viewed as the most suitable profession for women in Saudi Arabia and absorbs most of the STEM graduates. A female teacher's role is regarded as essential, as girls need to be educated by women in schools and universities (King and McInerney, 2014). The suitability is also based on working hours, holidays coinciding with those of their young, school-going, children, and guarantees of a female-only working environment. Universities in Saudi Arabia offer degrees in education for elementary teaching, but many subject teachers enter the profession with a bachelor's degree, and with no formal teaching skills or qualifications. University lecturers are required to have a PhD, and the university supports faculty members in pursuing postgraduate studies in Saudi Arabia and overseas through its scholarship programs. This study also revealed that participants favoured working in the university because of the opportunities to pursue postgraduate studies.

Finally, contrary to the situation in the UK and the USA (Falkenheim and Hale, 2015), this study revealed that, in Saudi Arabia, gender parity in STEM fields was not considered essential by Saudi Arabian girls. As mentioned in chapter 4, it is not necessary for girls to be encouraged to follow STEM careers, they will choose STEM careers if they want to as it is their choice. The World Economic Forum, report states that female STEM graduates in Saudi Arabia (21%) exceeded the same in the UK (16%) and the USA (8%) (Leopold *et al.*, 2016). Despite the high number of female graduates, Saudization only aims to integrate 30% Saudi women into the workforce by 2030 (Al-Saud., 2016). This aim could be interpreted as reflecting a realistic target or as sending a clear message that gender equality in Islam is not comparable to gender parity (Davids, 2015).

Saudization is transforming Saudi society and facilitating greater participation of women in the Saudi workforce, especially in retail and administrative positions (Rutledge and Shamsi, 2016). However, previously male dominated disciplines, such as engineering, challenge the gendered structure and the socio-cultural norms (King and McInerney, 2014); jobs in engineering are now being created for women mainly in the private sector or universities. The career prospects for girls are increasing, but they need guidance to understand and embrace the emerging careers for women in their society.

6.5 The importance of role models and work experiences on girls' motivation to enter STEM-related careers.

Gender-segregated educational settings facilitated the academic progress of the students in this study without the stereotypical conflicts observed in coeducational settings. Evidently, as students' daily encounters take place in female-only spaces, their attitudes and behaviours were influenced by the routinized practices in these environments. Several students chose to become school teachers based on their relationship with specific subject teachers, or their mothers who were teachers, and they aimed to teach the same subject. These teachers and mothers were role models, as they were knowledgeable about their field and the environment they worked in, which helped the students to make their decisions. Students were offered or sought advice from the school teachers about careers and were encouraged to pursue the STEM subjects in which they were achieving high grades (Gunderson *et al.*, 2012).

At the beginning of the foundation year, university faculty members targeted students to attract them to less popular majors, through an initial career fair and through direct contact. Students' views indicate that they gained new information about majors from experienced staff and subsequently decided to pursue majors that they had not previously considered, which contributed to transforming the structure. Scaffolding of advice and sharing experiences with girls was not limited to women. Fathers, brothers, and other extended family members were instrumental in encouraging students to follow careers in engineering based on their own experiences, motivating them to pursue careers in medicine. Much inspiration was gained from Saudi women and by men and women in other countries doing well in STEM subjects. Interestingly, it was revealed that these were family members who had or were attending universities in foreign countries through the King Abdallah Scholarship program (KASP). Family is central to decision-making in Saudi culture. It is clear from this study that familial dialogues, regarding studies, experiences in foreign educational settings, and women exploring sectors that were inaccessible in their homeland, had positive influences on the research participants. Through merging traits from Saudi Arabia and their host countries, (Barnett, 2015), KASP scholars are viewed as contributors to gradual cultural change in Saudi Arabia (El-Showk, 2017). This study further demonstrated that students were not familiar with prominent STEM professionals in Saudi Arabia or other countries, suggesting a lack of exposure to information about such professionals, who were not personally known to them. Thus, role models were identified as family and friends, individual school teachers, and professors in the university.

All public education in Saudi Arabia is government funded (Onsman, 2011), with 90% of high school graduates enrolling in universities (Barnett, 2015). There are fewer undergraduate majors for girls to select than boys, although the societal expectation now is that girls should have achieved at least a bachelor's degree. Several shifts in cultural expectations were noted in this study. Previously, many girls married before completing high school and few pursued undergraduate degrees. However, some women are now seizing an opportunity which they were not previously privy to, namely, completing high school and pursuing higher education. Even now, acquiring knowledge does not necessarily translate into an active career (Huyer and Hafkin, 2012). In this study, it was evident that education is fundamental for Saudi women, but paid employment is an option, not always the goal.

As the number of female STEM graduates in Saudi Arabia currently exceeds the available jobs, some students procured an employability advantage over their peers by pursuing new or less popular majors, and by actively increasing their credentials through voluntary work and participating in non-compulsory courses. Addressing claims regarding the mismatch between qualifications and skills (Arab News, 2018), relevant internships are mandatory for final year undergraduate students. These internships have a dual purpose: first, they give students a chance to experience the work environment, and second, they force reluctant parents to accept that their daughter is working and familiarising herself with the environment (Marmenout and Lirio, 2014). Attempts are made by organisations to provide an appropriate working environment for women during their internships, as well as when they are fully employed. Public companies tend to maintain female only workspaces that comply with the values of Saudi society and empower women within the confines of their space (Le Renard, 2008; 2014). Some private companies have mixed work spaces but adhere to Islamic etiquette, dress codes, and modesty. Generally, most women and men are comfortable with gender segregated work spaces, with common meetings held when necessary (Khoja, 2016).

Saudi Arabia has facilitated the emancipation of its women to a degree but strives to preserve their safety in keeping with Islamic law. To that end, the labour law prevents women from working in 23 hazardous industries and has created policies to aid the successful integration of women into the workforce. These policies include reviewing childcare facilities, defining suitable working hours and prohibiting gender-based salary discrimination (MoLSD, 2017). This study illustrated that for women, working and contributing to the growth of Saudi Arabia takes precedence for a time, until the responsibilities of raising a family become a priority. Since Saudi women have financial security from their husbands or fathers if unmarried (Kounsar, 2017), there may not be a compelling reason for most women to work.

Nevertheless, high divorce rates and financial independence are currently important considerations in Arab countries (James-Hawkins *et al.*, 2017).

This study highlights Saudi girls' confidence, as they believe that they can do anything. They expect to contribute more to society than previous generations and are eager to realise the plans outlined in Saudi Arabia's 2030 Vision, which is a recent motivator. The empowerment of women in the public sphere by enhancing opportunities for their participation in the workforce and building the knowledge economy are highly favourable. The recent lifting of the ban on women driving was an important strategy and significant transformation to Saudi society that will enable their geographic mobility and promote independence.

6.6 Original Contribution to Knowledge

This research is unique considering the privacy of Saudi Arabian girls and women is closely guarded by restricted access to strict, gender segregated social structures. Research, to date, has tended to focus on Saudi women as oppressed victims of society and has paid little or no attention to their acquisition of knowledge and empowerment. Since the formal introduction of education for girls in 1960, negotiating structural constraints through religion and the agency of both women and men has been essential for the advancement of female education. This study is the first of its kind that addresses this issue from the perspective of Saudi women, as their in-depth perceptions give a rare insight into structures that support or impede their progress in education and careers. It illustrates the significance of gender-segregated education in empowering girls and women to pursue STEM majors, which for this study included medical fields. Medicine was identified as a prestigious profession where the application of scientific knowledge was apparent and being a doctor was viewed with reverence in Saudi culture.

This study brings to the forefront key strategies that encourage students' aspirations and facilitated selection of university majors but which do not rule out the influence of other factors. Schools have a significant role to fulfil in encouraging interest in STEM subjects but need to be co-authors with the MoE on decisions. It illuminates the need for creating policies and practices that provide quality career guidance, with localised information, and which foster career enquiry from early grades in school. In Saudi Arabia, female STEM graduates exceed the available jobs, so there is a need to widen the career opportunities and majors offered at the universities.

Without government endorsement, political, cultural, and social norms in Saudi Arabia are largely upheld. Although agentic actions can result in minor changes, ultimately it is only government mandates that instigate or enforce the transformation of structures. The study highlighted that structures were being deliberately reproduced, often encouraged by mothers who were uncomfortable with the unfamiliar (Zoepf, 2010). This is consistent with the theory of structuration (Giddens, 1984).

With foresight and agency, school girls can dream and plan for careers that are not yet present in Saudi Arabia, with the 2030 Vision giving hope to them that these could materialise by the time they graduate from university. However, limitations posed by families and cultural norms cannot be dismissed, as, initially, these may still hinder the progress of a significant minority.

6.7 Recommendations

This case study research has generated powerful insights into many aspects of STEM education and careers in Saudi Arabia and can be considered a view through the window that, until now, has been opaque. It presents a new paradigm towards filling a gap in academic literature, as it brings to the forefront the representation of Saudi Arabian women in STEM education and careers from their lived experiences; a perspective not previously researched. This research highlighted the need to improve vital aspects of teaching and learning. Thus, recommendations focus on improving a number of aspects of high school education, including the implementation of the new curricula already in place in schools and a fresh emphasis on the dire need to establish career education in schools.

STEM education has been centre-stage on global political and educational agendas for almost two decades (Daugherty, 2013). Saudi Arabia aspires to becoming a knowledge economy, shifting reliance away from oil revenues and creating employment opportunities for citizens through Saudization and feminization. Massive investment in education has created a top-heavy cohort of STEM graduates, many of whom, especially women, are currently unemployed. The issue with unemployment is presumably temporary, with the 2030 Vision directing attention towards women participating in the workforce (Al-Saud., 2016). There is little doubt that female STEM graduates have a key role in the economy of Saudi Arabia for the foreseeable future. Therefore, it is essential to create the most suitable environment that will generate a continuing supply of female STEM graduates, thus the starting point is educational provisions in schools.

6.7.1 Recommendations for The Ministry of Education

The MoE provides a structure for schools and higher educational institutes, and it employs a highly prescribed, top-down model, particularly in schools. One major drawback of this approach is that it impairs the autonomy of highly educated female school principals and teachers who should to be contributors in decision-making processes. Perhaps a more serious disadvantage is the resulting negative effect on teacher motivation (Alothman and Robertson, 2015). El-Deghaidy *et al.* (2017) argue that teacher input is central to the development of progressive and sustainable educational programs in Saudi Arabia. MoE inspectors typically have extensive experience in education but may not be well acquainted with new pedagogies and preserve previous pedagogical practices, thus reproducing the structure (Bourdieu, 1977; Giddens, 1984). Teacher transitions from traditional to modern teaching methodologies across schools, could be eased if inspectors were to actively participate in professional development courses provided for teachers.

6.7.1.1 Engineering and Technology Curriculum

Computer education in schools needs to be addressed. Since technology is now a fundamental fixture in teaching and learning, teachers must be equipped to deliver a curriculum that teaches essential skills, including programming language(s). Although it is not common for schools to have courses related to engineering, embedding a robotics component in Information Technology/computing curriculum for all students from grades 4-10 is highly recommended. This would introduce students to engineering and computer programming thus, bridging the gap between school and university computer courses.

6.7.1.2 Teacher qualifications

A coordinated effort between the MoE, school administrators and the department of education in universities is necessary to ensure that potential teachers receive adequate support and supervision to gain the necessary skills to become effective teachers. All teachers should undergo formal teacher training, with teaching practice as the core component of the course. Whilst it is recommended that this take place before employment in schools, the shortage of teachers may render this difficult. Therefore, continuing professional development of school teachers should be mandatory, where teachers follow a structured program of training and evaluation in order to achieve a formal accredited teaching qualification.

6.7.1.3 Transitioning from high school to university

University outreach programmes targeting grade 12 students was evident in some schools but not all, as this is a huge task for universities to handle. Nevertheless, liaisons between schools and universities are essential to provide students with a realistic view of university life. Students benefit when schools and higher education institutes adopt an integrated system of transitions (Briggs *et al.*, 2012). The transition from Saudi Arabian public schools to university has raised concerns regarding students' English language skills and mathematics achievement.

Faculty members expressed a preference for high school students to be taught STEM subjects in English, however this is not currently feasible because the STEM curriculum in all public schools is taught in Arabic. It is viable for schools to enhance the English language skills of students. If students are taught the English language by capable English teachers in schools, they will acquire the necessary skills to understand and participate in university courses. Therefore, it is highly recommended that in addition to a bachelor's degree, teachers should have an internationally recognised English language proficiency certification for English teaching positions and current teachers should also be required to gain certification. This will improve the delivery of English language courses in schools and help students achieve higher GPAs in the Foundation Year.

6.7.2 Recommendations for schools

At the school level, the principals' expertise and training in education is crucial; the role demands that principals both engage in and manage the educational processes within their schools in an effective manner.

6.7.2.1 School Culture

There is a critical need to cultivate a collaborative culture in schools that fosters both bottom-up and top-down management strategies. Schools serve to benefit from supporting teacher collaborations within and across subject areas on a regular basis. Such networks encourage teachers to share good practice and original ideas. With respect to STEM education, they help teachers to understand the connections between subject areas and share perspectives on how to approach topics. This could also lead to the development of valuable resource banks of tried and tested activities. As noted above, teachers' participation in professional development courses should be compulsory. Following CPD courses, some teachers find it challenging to apply the same content in their classes, when they work in isolation (Mansour *et al.*, 2014). Thus, creating a collaborative school culture would foster a supportive

environment for teachers, promote standardization of pedagogical strategies, and give teachers a voice within schools.

6.7.2.2 School-home-community connections

Parents and schools have a joint responsibility in ensuring that children receive quality education and are supported during the process. Students reported limited contact between school and home, with few mothers attending meetings relevant to their progress. This calls for a strengthening of the relationship between school and home, as parents need to know what is happening in school and how they can better support their children (Crozier and Davies, 2007). Parents were identified as the main influencers in students' decisions; disseminating information to students was found to be more effective when parents were involved, for example (Rozek *et al.*, 2017).

Furthermore, as parents are a valuable resource for schools, it would be beneficial if schools involved mothers, women working in STEM fields, and alumni in a committee with STEM teachers to organise at least one cross curricular activity each year. This would utilise their individual expertise, encourage teamwork, and cultivate beneficial relationships within the community. This type of collaboration will enable mothers to discuss STEM subjects with their daughters from several different perspectives.

6.7.2.3 Student Skills Development

Students enjoy the excitement of experiments and can learn practical skills through active experiences, but these were not offered in all schools or across subjects, although the science curriculum includes practical activities. All teachers should be supported in providing opportunities for students to perform experiments. This is important, as students' attraction to STEM careers was influenced by their experience in carrying out experiments or having a desire to do so.

Learning takes place in classroom settings in Saudi Arabia, but there are many opportunities to extend learning beyond the classroom, through field trips. The MoE needs to review the list of acceptable venues for students to visit whilst considering their relevance to STEM education. These may include local museums (science and others), theme parks, laboratories, and companies. Focused visits require pre-planning with the venues so that students' complete relevant assignments during the visits. In this way, students will be able to understand the relevance of STEM subjects to various occupations and enhance their educational capital.

6.7.3 Approach to Career guidance

Limited guidance from schools and clear strategies for selecting majors was evident in this study, and many students failed to give concrete reasons for their choices. Thus, the reality of their aspirations and achieving them should both be deliberated. Hooley (2017) argues that career guidance in Saudi Arabia is conceived as an agent of social change, yet, cultural and political support whilst crucial, are not guaranteed.

6.7.3.1 Career Guidance Policy

On the basis of its findings, this research proposes that a career guidance policy be introduced at school level, with a framework guiding progression in career education, from elementary through to high school. To embed the policy effectively would compel each school to employ a dedicated career counsellor, thereby detaching this role from that of the school counsellor. Thus, the introduction of degree level courses in the universities, leading to accredited career education qualifications, would be critical in generating a supply of career counsellors in all schools.

6.7.3.2. Career Guidance Resources

Since students ask teachers for advice about their suitability for certain STEM majors, it is imperative that teachers are able to convey information about the applications of their fields in the Saudi context in different ways. Engaging posters, illustrating accurate and relevant information, interesting facts that respect cultural sensitivities are one resource that could be developed. Such resources, if pitched at different educational levels, can stimulate students' STEM interest and inspire them to seek additional information about the careers.

King and McInerney (2014) argue that difficulties arise when an attempt is made to implement policies borrowed from other countries without studying the role of culture. A reasonable approach to tackle this issue could be the development of a careers website through collaboration between the MoE, MoLSD, and local industries. A centralised careers data base and website would benefit Saudi society, in general. Parents were identified as key to decision making in this study, and Rozek *et al.* (2017) point out that parents can influence choices and stimulate informed discourse about careers, if provided with the relevant information. Therefore, it is suggested that short videos of Saudi Arabian women and men explaining their jobs and their transitions from school or university to work be produced and accessed through the website. In addition to providing localised data about all types of careers and workforce participation statistics, it can serve as a platform to showcase the achievements of Saudi Arabian researchers in STEM and other fields.

This research investigated the representation of Saudi Arabian girls and their perceptions regarding STEM education and careers. This section has presented recommendations based on the findings in this study. Saudi Arabian women are overrepresented in STEM education, where the range of majors is limited, but are highly underrepresented in STEM careers. It is anticipated that current measures to increase the participation of women in the labour market will also increase their representation in STEM fields. The next section suggests further academic research that extends the current study and addresses its limitations.

6.8 Further research

This study introduces new research to the existing STEM literature and provides a pathway to further research. The following are some suggestions for future academic research:

1. This research has considered female-only perspectives. A comparative study of the decision-making strategies utilised by male and female foundation year students would shed light on any gendered practices pertaining to the development of STEM aspirations.
2. Considering the significant contributory effect of parents and school teachers on students' decisions, it would add value to a research of this nature to gather data on parents and teachers' perspectives on women in STEM education and careers.
3. It is important that student interest be nurtured prior to grade 11, where students continue or exit from STEM education and careers. An important area of research would be to investigate the factors that deterred male and female students from selecting the science track in high school and pursuing STEM education and careers. Thus, a study of non-STEM foundation year students would be beneficial in uncovering these factors.
4. The data for this study was collected and analysed prior to the implementation of recent reforms initiated by Crown Prince, Mohammad bin Salman. It would be valuable to conduct a follow-up study to this research to ascertain how the reforms have affected the STEM-related education and careers of women.

6.9 Limitations of the Study

This study was conducted in a unique setting; therefore, it makes no claims of generalisation. Any attempts to generalise its findings should consider the following parameters**:**

- Despite an extensive literature search, this study was limited by the lack of research about STEM education or careers related to Saudi Arabian women. Therefore, the

background to my research draws mainly on STEM literature from secular western settings, whilst both religious and cultural perceptions are pertinent to studies related to Saudi Arabia.

- This study was confined to one public university in Saudi Arabia, which most (98%) of the FYS in this study joined after attending public (state) Saudi Arabian schools. The main reason for choosing the participating university was the range of STEM majors available for girls there. The second reason was the ease of access to the university. The participants in the study were all female, hence the male viewpoint is absent in this research. As a female researcher, access to a male only-campus or conducting telephone interviews with male students is not acceptable. In addition, it would have been almost impossible to find a male administrator to support my research and administer and collect the questionnaires, all of which was done in this study by females.
- The period between participants completing the questionnaire and being contacted for interviews was approximately three months. During this time, the preferred majors of many students changed. As the competition for seats became apparent, they became unsure of the major they would be qualified to pursue. This indirectly affected the composition of the interview sample; preferred majors had been used as the criterion for purposive sampling. However, this added a new dimension to the study, as students disclosed why their decisions had changed so soon after joining the university.
- It was also difficult to contact some participants for the interviews, as some telephone numbers had changed, or they did not respond to calls. In addition, a few did not follow through with pre-arranged interviews. Given the influence of parents, especially mothers, on their daughter's future careers, their perspective and perceptions would have added value to my research but could not be done due to a lack of time.

6.10 Self-reflection

When reflection is associated with experience, learning, and action (Reynolds, 2011), its meaning varies. By reflecting on practice, people recapture their experience, think about it, mull it over, and evaluate it (Boud *et al.*, 2013). I recognize that I am fortunate to have embarked on this research study in a truly exclusive environment. Sharing insights into the largely unknown female spaces, where STEM education is taking place in Saudi Arabia, is my personal contribution to women in a society that is often misunderstood. As a STEM graduate and educator, I reflected on my own practice as a former teacher during this study, the strategies that I used to facilitate independent learning and enthuse a love of sciences,

especially chemistry. During interviews with students and faculty members, I was intrigued to learn about their journeys and the similarities with, and differences from, my own experiences. Their willingness to share details and stories, and likes and dislikes, left a desire to share my experiences with them. Nevertheless, I resisted, as I did not want to influence their responses or shift the focus from them to me.

Schön (1983) distinguished between reflection that takes place during action and retrospective reflection (James and Brookfield, 2014; van Velzen, 2015). I learned to work around socio-cultural nuances that had the potential to hamper my research, such as accessing participants in a sensitive manner. I considered every obstacle as a personal challenge and dealt with it with finesse. Despite the interviews being conducted over the telephone, rather than face to face, I developed a good rapport with interviewees. As I was not able to observe their body language, they were also not able to observe mine and witness my reactions to their dreams and aspirations. After listening to the interview recordings, I reflected on the vast career choices that I had available to me, as compared to those of the participants. I understood that their motivation for STEM was no different from mine, yet I knew from the outset what I would be majoring in, while they did not. I appreciated that patience and following the path that is laid down are important life lessons demonstrated by the participants. After the many years of involvement with education in Saudi Arabia, I am still intrigued by the parallel social and educational systems that exist for men and women and how they still enable empowerment of women within them. Life-changing transformations have occurred for Saudi Arabian citizens during my research, the most significant being the royal decree permitting women to drive in June 2018 and the disclosure of the 2030 Vision goals.

This research provides an insight into the representation of Saudi Arabian women in STEM education and careers. The case study explored the views of Saudi university students who are intending to study STEM majors, students who have already embarked on studying a STEM major, and university faculty members who teach STEM-related subjects. It revealed the onset of students' aspirations and the factors that shaped their decisions to pursue STEM education. Furthermore, it highlighted the complexities surrounding the actualization of student aspirations; most profoundly, the uncertainty of acceptance into their preferred major and the current shortage of jobs to meet the supply of female STEM graduates. Clearly, STEM education is important, as it leads to an elevation in social status and some of the more prestigious careers.

This was an amazing journey through which I have grown, both as a practitioner and a researcher, striving to present a true representation of the case.

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APPENDICES

Appendix I

Project Information Sheet

Women's representation in STEM related education and careers: A case study of second year female university students in Saudi Arabia

What is the project about?

The aim of this research is to determine the representation of women in STEM education and careers in Saudi Arabia. Girls and women represent untapped human capital that could enhance the STEM workforce (Hutchinson, 2014). Hence the underrepresentation of women in STEM careers is a global concern; scientific advances are strategic to economic competitiveness and countries need to utilize their human capital (Beede and Julian, 2011, Huyer and Hafkin, 2012, Kelly *et al.*, 2014).

What would you taking part in the project involve?

You are being invited to take part in a research project because you are a female university student in the foundation year. Your participation in the study would be as follows:

1. Completion of a two-page questionnaire
2. The researcher may also contact you, if you are willing to participate in a face-to-face interview.

What will happen to the information you provide?

Interviews will be recorded and access to recordings will be limited to the researcher. Recordings will not be included in full in the final written record of the research. Quotations may be used in presentations or related documentation and publications but participants in the research will not be identified by name at any time.

Please take time to decide whether or not you wish to take part. Ask if there is anything that is not clear or if you would like more information. If you do decide to take part, you will be given this information sheet to keep (and be asked to sign a consent form) and you can still withdraw at any time without giving a reason.

Thank you very much for your time. If you have any queries regarding this request, then please contact me, or my Principal Supervisor, whose contact details are given below.

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Principal Supervisor: Professor Tehmina N Basit, Staffordshire University, UK

Email: t.n.basit@staffs.ac.uk

Appendix II

Questionnaire for Foundation Year students

Section 1: Educational Experience

1. **Which were your favourite subjects in school?** (Tick as many as apply)

English ☐ Mathematics ☐ Biology ☐ Chemistry ☐ Physics ☐ Computer science ☐

other(s) ☐. . . . . .

2. **Did you find any of these subjects difficult?** (Tick as many as apply)

English ☐ Mathematics ☐ Biology ☐ Chemistry ☐ Physics ☐ Computer science ☐

other(s) ☐. . . . . .

3. **What major do you want to study?** _____

4. **When did you become interested in your chosen major?** (Tick one box only)

Grade 4-6 ☐ Grade 7-9 ☐ Grade 10-12 ☐ after grade 12 ☐ Not sure ☐

5. Please tick one answer for each of the following statements

I decided to follow the science path in grade 11 because	Yes	No	Not sure
I was told that I was good at these subjects by teachers			
I liked how the subjects were applied in real life			
I was inspired by Saudi women doing well in these subjects			
I was inspired by men /women in other countries who were good in these subjects			

My family encouraged me			
It will be easy to find a job in this field			
Lessons in primary and middle school were interactive and fun			
Programmes on the TV/Internet sparked my interest			

Section 2: Career Decisions

6. Please tick one answer for each of the following statements

My school	Yes	No	Not sure
Has a teacher who specialises in careers guidance			
Holds meetings with parents and students about careers			
Hosts visits from female specialists in different field			
Invites school graduates to talk to students about university/work experiences			
Provides materials to prepare students for choosing majors			
Organises visits for students to universities/colleges			
Arranges or encourages work placements			

7. Please tick one answer for each of the following statements

I used the following strategies to help me decide on my college major	Yes	No	Not sure
Websites to help me find careers that match my personality			
Discussed career options with my parents			
Discussed career options with my grandparents			
Asked my friends to tell me what they thought would be a good career for me			
Spoke with teachers in my school to get their views			

about my abilities			
Spoke with the careers counsellor in my school			
Attended information sessions for students at local career fairs			
Listened to talks by working women to find out about their experiences			
Obtained one or more work placements to observe different jobs			

Section 3: About you

8. The high school that I graduated from was (Please tick all that apply)

Private ☐ Public ☐ Saudi Arabian ☐ International ☐

My high school was in the city of _____

9. My nationality is _____

Thank you for participating in this research study. I may need to contact you for a follow-up interview. All interviews will be confidential. and your identity will not be revealed in the research. Please kindly write your contact details clearly here if you are willing to be interviewed.

Name: _____ (optional)

Email: _____ Telephone: _____

Appendix III

Project information sheet

Women's representation in STEM related education and careers: A case study of second year female university students in Saudi Arabia

What is the project about?

The aim of this research is to determine the representation of women in STEM education and careers in Saudi Arabia. Girls and women represent untapped human capital that could enhance the STEM workforce (Hutchinson, 2014). Hence the underrepresentation of women in STEM careers is a global concern; scientific advances are strategic to economic competitiveness and countries need to utilize their human capital (Beede and Tiffany, 2011, Huyer and Hafkin, 2012, Kelly *et al.*, 2014).

What would you taking part in the project involve?

You are being invited to take part in a research project because you are a female university student pursuing a STEM major. Your participation in the study would be as follows:

1. Completion of a two-page questionnaire
2. The researcher may also contact you, if you are willing to participate in a face-to-face interview.

What will happen to the information you provide?

Interviews will be recorded and access to recordings will be limited to the researcher. Recordings will not be included in full in the final written record of the research. Quotations may be used in presentations or related documentation and publications but participants in the research will not be identified by name at any time.

Please take time to decide whether or not you wish to take part. Ask if there is anything that is not clear or if you would like more information. If you do decide to take part, you will be given this information sheet to keep (and be asked to sign a consent form) and you can still withdraw at any time without giving a reason.

Thank you very much for your time. If you have any queries regarding this request, then please contact me, or my Principal Supervisor, whose contact details are given below.

Maryam Sani,
PhD student,
Staffordshire University, UK.
Email: s034299e@student.staffs.ac.uk

Principal Supervisor: Professor Tehmina N Basit, Staffordshire University, UK

Email: t.n.basit@staffs.ac.uk

Appendix IV

Questionnaire for Third Year students

Section 1: Educational Experience

1. The high school that I graduated from was (Please tick one box only)

Saudi Arabian public ☐ Saudi Arabian private ☐ International ☐ other ☐ please state _____

2. My high school was in the city of: _____
3. **Which were your favourite subjects in school?** (Tick as many as apply)

English ☐ Mathematics ☐ Biology ☐ Chemistry ☐ Physics ☐ Computer science ☐ other(s) ☐ Please state _____

4. **Did you find any of these subjects difficult?** (Tick as many as apply)

English ☐ Mathematics ☐ Biology ☐ Chemistry ☐ Physics ☐ Computer science ☐ other(s) ☐ Please state _____

5. **What major are you studying?** _____
6. Was this major your first choice when you started the university? No ☐ Yes ☐
7. **When did your interest in your chosen major begin?** (Tick one box only)

Grade 4-6 ☐ Grade 7-9 ☐ Grade 10-12 ☐ after grade 12 ☐ Not sure ☐

8. Please tick one answer for each statement

I decided to follow the science path in grade 11 because:	Yes	No	Not Sure
I was told that I was good at these subjects by teachers			
I liked how the subjects were applied in real life			
I was inspired by Saudi women doing well in these subjects			
I was inspired by men / women in other countries that were good in these subjects			
My family encouraged me			
It will be easy to find a job in this field			
Lessons in primary and middle school were interactive and fun			
Programmes on the TV/Internet sparked my interest			

9. I would have liked my high school to have
    a) More depth of information in the curriculum ☐
    b) Hands-on practical skills training ☐
    c) Technology related activities☐
    d) Don't know ☐
    e) Other _____

Section 2 Career Decisions

10. Please tick only one choice for each statement below

I used the following strategies to help me decide on my college major:	Yes	No	Not Sure
Websites to help you find a career that matches your personality			
Discussed career options with my parents			
Discussed career options with my grandparents			
Discussed career options with older siblings			
Asked my friends to tell me what they thought would be a good career for me			
Spoke with STEM teachers in my school to get their opinions about my abilities			
Spoke with the careers counsellor in my school			
Attended information sessions for students at local career fairs			
Listened to talks by women working in STEM to find out about their experiences			
one or more work placements to observe different jobs			

11. Please state if your school supports you in the following ways: (tick yes or no)

My school supported us moving to university or jobs by:	Yes	No
Having a teacher who specialises in careers guidance		
Holding meetings with parents and students about careers		

Hosting visits from female specialists in different fields to talk to students		
Inviting Alumni to talk to students about university/work experiences		
Providing materials to prepare students for choosing majors		
Organising visits for students to universities/colleges		
Arranging or encouraging work placements		

Other _____

12. My nationality is _____

Thank you for participating in this research study. I would like to contact you for a short follow-up interview. All interviews will be confidential, and your identity will not be revealed in the research. Please provide your contact details clearly below if you are willing to be interviewed.

Name: _____ (optional)

Email: _____ Telephone: _____

Appendix V

Project information sheet

Women's representation in STEM related education and careers: A case study of female university students in Saudi Arabia

What is the research project about?

The aim of this research is to determine the representation of women in STEM education and careers in Saudi Arabia. Girls and women represent untapped human capital that could enhance the STEM workforce (Hutchinson, 2014). Hence the underrepresentation of women in STEM careers is a global concern; scientific advances are strategic to economic competitiveness and countries need to utilize their human capital (Beede and Tiffany, 2011, Huyer and Hafkin, 2012, Kelly *et al.*, 2014).

What would you taking part in the project involve?

You are being invited to take part in a research project because you are the head of STEM department in the female section of a university. Your participation in the study would be a completion of a short questionnaire and a telephonic interview.

What will happen to the information you provide?

Interviews will be recorded and access to recordings will be limited to the researcher. Recordings will not be included in full in the final written record of the research. Quotations may be used in presentations or related documentation and publications but participants in the research will not be identified by name at any time.

Please take time to decide whether or not you wish to take part. Ask if there is anything that is not clear or if you would like more information. If you do decide to take part, you will be given this information sheet to keep (and be asked to sign a consent form) and you can still withdraw at any time without giving a reason.

Thank you very much for your time. If you have any queries regarding this request, then please contact me, or my Principal Supervisor, whose contact details are given below.

Maryam Sani,
PhD student,
Staffordshire University, UK.
Email: s034299e@student.staffs.ac.uk

Principal Supervisor: Professor Tehmina N Basit, Staffordshire University, UK.

Email: t.n.basit@staffs.ac.uk

Appendix VI

Questionnaire for faculty members

1. Please select the department you work in: Biology☐ Biochemistry☐ Chemistry ☐ Computing☐Dentistry☐Engineering☐Mathematics☐Medicine☐Physics☐
2. How long have you worked in Higher Education? _____
3. How long have you worked in this university? _____
4. What is your role in the faculty? _____
5. Was this your first choice of profession? Yes ☐No ☐
6. Did you study at a university in Saudi Arabia? Yes ☐No ☐
7. What is your university Major? _____
8. What is your highest degree that you have achieved? BSc MSc/MA PhD _____
9. Have you faced barriers in following your career? Yes ☐ No ☐Don't know ☐
10. Do you think girls are encouraged to follow careers in science, technology, engineering, mathematics and medicine? Yes ☐No ☐
11. If you were to make recommendations about the type of education offered in high school to help female Saudis enter your subject, what would you recommend?
    f) More depth of information in the curriculum
    g) Hands-on practical skills training
    h) Technology related activities
    i) Don't know
    j) Other _____

Thank you for participating in this research study. I would like to contact you for a short interview. All interviews will be confidential, and your identity will not be revealed in the research. Please provide your contact details clearly below if you are willing to be interviewed.

Name: _____ (optional)

Email: _____ Telephone: _____

Appendix VII

Interview schedule: Foundation year students

1. Name
2. Which year of study are you currently in?
3. What made you continue studying after graduating from high school? What other options were available to you?

Choice of major

4. Which major do you hope to pursue?
5. Do you think you had enough information to help you choose your major?
6. If you had the choice to study any major at all what would it be? Explain
7. Is your major popular with Saudi girls? Why do you think this is the case?
8. Can you tell me why you chose your major? Who or what encouraged your decision?
9. Who do you think had the most influence on your decision?
10. Did anyone try to discourage you from pursuing this major? What were their reasons?

High School

11. Tell me about your high school, overall how would you describe your high school experience?
12. Did the subjects that you liked in school influence your choice of major? How?
13. Did the grades that you achieved in school influence your choice?
14. Were your lessons interactive? If yes, can you explain what types of interactions were used?
15. Did all teachers use interactive methods in your lessons? If not in which subjects?
16. In your school where did students get information about different careers?
17. In which grade level do you think students should be introduced to career options?
18. What kinds of things did your school do to help you prepare for university?
19. You mentioned listening to women who work in STEM, can you tell me about any of these ladies? Where did you listen to them? What did you find most interesting about them?

STEM careers

20. Does your university host outreach events to attract high school students to STEM majors?
21. Do you think there are the barriers to girls following STEM careers? If yes what are they and how can they be eliminated?
22. Do you think it is important for girls to follow STEM careers? Why?
23. How can more girls be encouraged to follow STEM careers?
24. Do you think women are needed in your field? if so why?
25. Where would you like to work after graduation?
26. Will you have the chance to do work experience related to your major before graduating? When?
27. Can you tell me about the types of jobs that are available for graduates in STEM?
28. At what age or for what reasons do you think you would stop working?

Family

29. What is the highest level of education of your father?
30. What is the highest level of education of your mother? What is the employment status of your mother?
31. Do you have older siblings? If yes, how many and what gender?
32. What have your siblings studied?
33. What jobs do they have?
34. How do you think you can help Saudi Arabia achieve its 2030 vision?

Appendix VIII

Interview schedule: Third year STEM students

1. Name
2. Which year of study are you currently in?
3. What made you continue studying after graduating from high school? What other options were available to you?

Choice of major

4. Which major are you pursuing? Was this your first choice?
5. Do you think you had enough information to help you choose your major?
6. If you had the choice to study any major at all what would it be? Explain
7. Did your preferred major change after the foundation year? If yes how/why?
8. Is your major popular with Saudi girls? Why do you think this is the case?
9. Can you tell me why you chose your major? Who or what encouraged your decision?
10. Who do you think had the most influence on your decision?
11. Did anyone try to discourage you from pursuing this major? What were their reasons?

High School

12. Tell me about your high school, overall how would you describe your high school experience?
13. Did the subjects that you liked in school influence your choice of major? How?
14. Did the grades that you achieved in school influence your choice?
15. Were your lessons interactive? If yes, can you explain what types of interactions were used?
16. Did all teachers use interactive methods in your lessons? If not in which subjects?
17. In your school where did students get information about different careers?
18. In which grade level do you think students should be introduced to career options?
19. What kinds of things did your school do to help you prepare for university?

20. You mentioned listening to women who work in STEM, can you tell me about any of these ladies? Where did you listen to them? What did you find most interesting about them?

STEM careers

21. Does the department or university host outreach events to attract high school students to STEM majors?
22. Do you think there are the barriers to girls following STEM careers? If yes what are they and how can they be eliminated?
23. Do you think it is important for girls to follow STEM careers? Why?
24. How can more girls be encouraged to follow STEM careers?
25. Have you personally spoken to any high school students about their future careers? What were the circumstances?
26. Where would you like to work after graduation?
27. Will you have the chance to do work experience related to your major before graduating?
28. Can you tell me about the types of jobs that are available for graduates in your field?
29. At what age or for what reasons do you think you would stop working?

Family

30. What is the highest level of education of your father?
31. What is the highest level of education of your mother? What is the employment status of your mother?
32. Do you have older siblings? If yes, how many and what gender?
33. What have your siblings studied?
34. What jobs do they have?
35. Do you think you can as a female STEM graduate help Saudi Arabia achieve its 2030 vision? Explain.

Appendix IX

Interview schedule: Faculty members

1. Name / faculty
2. How long have you worked in Higher education?
3. What is your role in the faculty?
4. Can you tell me why you chose your major?
5. Who or what encouraged your decision?
6. Did you attend university in Saudi Arabia? If not, where and why?
7. Why and where did you study for your PhD?
8. Was teaching your first choice of profession?
9. If no what was it and why did you not pursue it?
10. Have you worked continuously in this field since you graduated, or did you take any breaks? If yes, for what reasons?
11. Can you tell me if the university supports career breaks? Can you explain how

Students and their education

12. What do students say about why they chose your subject?
13. What do students know about your subject before they start?
14. Who provides this information for them?
15. What other sources of information should be available to the students?
16. In which grade level do you think students should be introduced to career options?
17. Overall how has the number of students in your faculty changed in the past five years?
18. Why do you think this change has taken place?
19. What changes if any have you personally made to the way in which you deliver your courses?

STEM careers

20. Do you think it is important for girls to follow STEM careers? Why?
21. Have you faced barriers in following your career?
22. If yes, can you explain what they were and how you overcame them?
23. In what ways do you think girls are discouraged from entering STEM fields?
24. How can more girls be encouraged to follow STEM careers?

25. Do you think boys and girls are equally encouraged to follow STEM careers?
26. What is the degree completion rate of female students undertaking STEM degrees?
27. For what reasons do students leave the course before graduation?
28. Can you tell me about the types of jobs that are available for female STEM graduates in the country?
29. Do students have the opportunity to carry out work experience before they graduate? In which year of their studies?
30. If you were to make recommendations to policymakers about the type of STEM curricula and pedagogy offered in high school to promote STEM-related education and careers for female Saudis, what would you recommend?
31. How do you see the role of female STEM graduates in contributing to the 2030 vision of Saudi Arabia?

Appendix X

Ethical Approval

STAFFORDSHIRE UNIVERSITY

Dr Noel Morrison
Director of Student & Academic Services

Student & Academic Services
Staffordshire University
College Road
Stoke-on-Trent ST4 2DE
United Kingdom

n.morrison@staffs.ac.uk
www.staffs.ac.uk

Maryam Sani
[redacted]

5th April 2016

ETHICAL APPROVAL FEEDBACK (Proportionate Form)
FACULTY OF BUSINESS, EDUCATION & LAW

Student Name:	**Maryam Sani**
Title of Study:	**MPHIL/PhD Education**
Title of Project:	**Women's representation in STEM related education and careers. A case study of second year female university students in Saudi Arabia**
Status of Approval:	**Approved – Action Now Required**

Your project proposal has now been approved by the Faculty's Ethics Committee. You can now begin to work on your proposed study.

Your project must commence within 12 months for this approval to remain valid. If your project does not begin within this timescale a further application for ethical approval must be made.

Sharon Inglis .....
Chair of the Faculty of Business Ethics Panel Date: 5th April 2016

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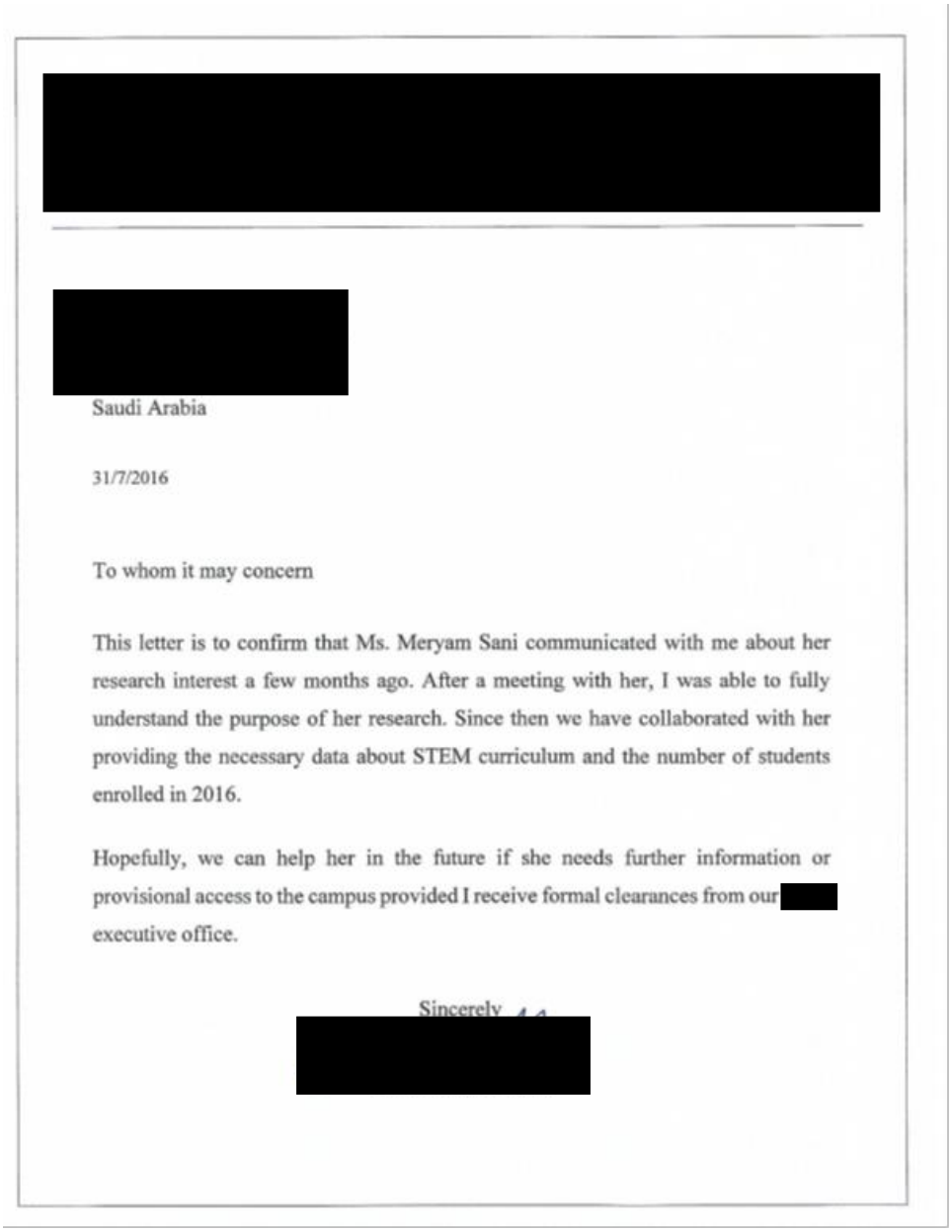
Appendix XI

Informed Consent Letter



[redacted]

[redacted]
Saudi Arabia

31/7/2016

To whom it may concern

This letter is to confirm that Ms. Meryam Sani communicated with me about her research interest a few months ago. After a meeting with her, I was able to fully understand the purpose of her research. Since then we have collaborated with her providing the necessary data about STEM curriculum and the number of students enrolled in 2016.

Hopefully, we can help her in the future if she needs further information or provisional access to the campus provided I receive formal clearances from our [redacted] executive office.

Sincerely

[redacted]