# An Exploration of Female Students' Choices, Experiences and Future Aspirations of Studying Undergraduate Mathematics and Engineering Programmes in Iran

A thesis submitted to the University of Manchester for the degree of PhD in the Faculty of Humanities

**2018**

**Nooshin Jahangiri**

**School of Environment, Education and Development**

## Contents

**Word Count** **80,295**

# List of Tables

# List of Figures

# Abbreviations

| | |
|---|---|
| **BSC** | Booklet of Selecting Courses |
| **DfS** | Department of Education |
| **EE** | Electrical Engineering |
| **FW** | Figured Worlds |
| **HE** | Higher Education |
| **MI** | Mathematical Identity |
| **MCHE** | Ministry of Culture and Higher Education |
| **NRHE** | National Report of Higher Education |
| **NSF** | National Science Foundation |
| **RPHE** | Research and Planning in Higher Education |
| **RQs** | Research Questions |
| **STEM** | Science, Technology, Engineering and Mathematics |
| **TIMSS** | Trend in International Mathematics and Science Score |
| **WISE** | Women into Science and Engineering |
| **WSCC** | Women's Social and Cultural Council |

## Abstract

This study investigates the relationship between gender and participation in mathematics and engineering undergraduate degree programmes in Iran. The number of female students enrolling in Iranian Higher Education (HE) is relatively high and this remains the case in mathematics and most engineering programmes. However, the number of female graduates gaining employment in engineering and STEM-[science, technology, engineering and mathematics] related jobs in Iran remains relatively low, with gender discrimination in recruitment practices identified as a key barrier. This presents a contradiction which makes Iran a particularly interesting context to study gender in mathematics and engineering in HE.

This study adopts a narrative inquiry approach to investigate how Iranian female students studying mathematics and engineering describe their choice of subject, experience of studying at university, and their future aspirations. It seeks to investigate how the social, cultural and historical structures of Iranian society shape the way these students narrate their identity as a mathematics or engineering student. In-depth analysis highlights how they position their degree as offering more or less 'capital' (Bourdieu) which resources their future identities of becoming successful career women in STEM-related professions. In doing so, these women feel able to navigate barriers to success by using their capital to improvise and exert agency over their future trajectories. In sum, I suggest the predominance of 'moving abroad' as a theme across the interviews is a consequence of the aforementioned contradiction between their desire to become successful career women whilst facing gendered discrimination in the labour market.

## Declaration of Original Contribution

No portion of the work in this thesis has been submitted in support of an application for another degree or qualification from this or any other university or institute of learning.

## Copyright Statement

*What I have done is worthy of nothing but silence and forgetfulness, but what God has done for me is worthy of everlasting and thankful memory.*

Joseph Hall (1574-1656), English bishop & writer

*Magnificent buildings decay by the dint of time*
*And exposure to the elements wrecks even a house of flint*
*But the poetic edifice I have erected in rhyme*
*Shall endure the contagion of the rain and the sun*
*I am deathless, I am the eternal Lord*
*For I have spread the seed of the word*
*For three decades have I thus suffered to restore*
*This Persian tongue and now my work is done.*

Ferdowsi (935 AD-1020), Persian Poet

## Acknowledgments

I would like to express my appreciation to my 1st supervisor Dr Laura Black, who has been my main motivation for writing this thesis, and thus without whom I have no doubt this thesis would not have been written. I am also thankful to my 2nd supervisor, Dr Pauline Previtt, for the time she spent with me and for her comments and guidance.

I would like to extend gratitude to my family, to my mother (Mrs Nasrin Asadi), to my father (Dr Rahmatollah Jahangiri), for all the support and encouragement that he gave me from early age until now, to my younger brothers (Farshid and Farshad), to my cousin (Miss Ellahe Farzaneh) and my dog (Paris) who were always there to cheer me up. Without their blessing, I would not have reached where I am today.

# Chapter 1: Introduction

## 1.1 Background

This research focuses on female students who are undertaking undergraduate engineering and mathematics programmes at university in Iran. It uses a narrative inquiry approach to explore how women speak of their choice to study their degree programme, their experiences of studying mathematics or engineering, and their future career aspirations. These narratives have been analysed using Holland et al.'s (1998) theory of Figured World's (FW hereafter) supplemented with Bourdieu's theory of capital. The purpose is to answer the following Research Questions (RQs hereafter):

- RQ1. How are the cultural-historical-economic structures and conditions of Iran manifest in Iranian female STEM students' narratives regarding their choices, experiences and aspirations?
    - RQ1a. What forms of capital are apparent in female students' narratives about their choices, experiences and aspirations?
- RQ2. How do Iranian female STEM students position themselves in relation to such contextual conditions?
    - RQ2a. In what ways do female STEM students display a sense of agency in their narratives about their choices, experiences and aspirations?

In recent times, women have entered HE in Iran in increasingly higher proportions, a trend which has been a major concern at state level due to the apparent impact on the Iranian labour market. In 2012, such concerns fuelled the introduction of admissions guidelines for universities by the HE Ministry, which were designed to restrict the number of female students in some fields, mainly engineering (explained more in Section 1.2). The introduction of these guidelines was a key motivation for this research since I felt it highlighted contradictions in the Iranian HE sector (i.e. that many female students desire to study engineering but face barriers and restrictions in doing so which relate to their gender). This led me to consider how and why women

choose such degree programmes and how they experience 'being a student' in this context. It is worth mentioning that at the time of interview (2014-2015) this guideline was still in place.

The evidence regarding increases in the number of women in Iranian universities can be seen if we compare data from 1991 onwards. In 1991, 29% of the student population was female but by 2012 this figure was 63% (BBC Persian, 2012). Furthermore, female students have become more prominent in traditionally male-dominated courses such as agricultural engineering and in the sciences, including mathematics and physics (see Figure 2 in Chapter 2). Despite this obvious increase, however, there is insufficient research in Iran which examines why this increase has taken place, or rather why women choose to study such programmes. The research which does exist (Rezaei, 2012; Shavarani, 2006; Khavar et al., 2006; Hashimi et al., 2012; Rezaei-Rashti, 2011, 2013) mainly observes the increase in female students in HE in general and, therefore, does not focus on mathematics or engineering in particular. Those that do focus on mathematics and engineering in Iran (Kiamanesh, 2004; Saed Zadeh et al., 2014; Nejat et al., 2011, 2012; Aghajani et al., 2012; Sharifi Saki et al., 2014; Shashaani et al., 2001) adopt a mainly quantitative approach and hence they do not consider the experience and decision-making of students studying these programmes through in depth accounts of their meaning making. Here, I argue that a qualitative understanding of this issue is necessary since we know from elsewhere in the literature that decisions to choose mathematics and engineering are influenced and mediated by the social context in which the student is situated (Solomon, 2011, 2012; Mendick, 2005a, 2005b). A similar argument is made in the non-STEM literature (e.g. Reay et al., 2001) on HE access. Therefore, a key aim of this study has been to identify the reasons that lead Iranian female students to participate in engineering and mathematics programmes and how such reasons are situated in the socio-political-economic history of Iran in the post-revolution era.

## 1.2 Setting the Scene: the 2012 HE Ministry Admissions Guidelines to Restrict Female Access to HE

The Iranian Ministry of HE's 2012 guidelines, which reduced the number of women entering some university courses, appeared first in a government-published booklet

given to students to advise them on selecting courses (called Booklet of Selecting Courses, hereafter BSC) (BSC, 2012). This received much attention from the media both inside Iran and globally. Below, I provide information on how it was introduced and how it was reported in media.

In 2011, Dastjerdi, the Vice President of educational measurement in Iran, announced that, if the increasing numbers of women in universities could not be controlled, female participation in universities would reach 70% for the upcoming years (BBC Persian, 2011). On 6 August 2012, BSC published a list of courses at different universities across the country that were to become male-dominated, meaning that only men or more men would be permitted to study those subjects (Human Rights Watch, 2012). 36 out of 105 public universities across the country would thus limit female participation in 77 academic fields such as engineering, science, mathematics, accountancy and education, most of which were engineering fields, which until 2011 were equally open to both men and women (Mehr News, 2012).

According to BSC (2012), among these academic programmes - electrical engineering, agricultural (machinery) engineering and mechanical engineering - were popular subjects that were required to reduce the number of female candidates (see Table 1 below for more detail).

**Table 1:** List of courses that reduced the level of women in universities

| | **Subject Name** |
|---|---|
| **Humanities** | Education Trends in Educational Technology. Political Science. Accounting. Administration. Government Management. Industrial Management. Hospitality Management. Tourism Management. Archaeology. Persian Language and Literature.<br><br>Social Science Research Social Trends. Social Work. Economic trends of Business Economics. History. General Psychology. Geography and Urban Planning. Geography and Rural Planning. Geography and Tourism Planning. |
| **Experimental Science** | Veterinary Science. Meat Inspection. Pure Chemistry. Geology. Animal Science Biology. Applied Chemistry. |
| **Mathematics and Engineering** | Computer Engineering. Computer Science. Chemical Engineering. Industrial Engineering. Civil Engineering. Surveying Trends. Railway Engineering. Marine Engineering Shipyard Trends. Safety Engineering. Petroleum Engineering. Polymer Engineering. Engineering Physics. Contacts and Marine Electronics.<br><br>Trends in Agricultural Engineering Mechanics. Agriculture Water orientation. Agricultural Engineering. Animal Science. Agricultural Engineering Agricultural Mechanization. Agriculture Medical Plant. Agriculture Horticulture. Agriculture Horticultural Science.<br><br>Materials Engineering, Metallurgy Industry Trends. Extractive Metallurgy Materials Engineering Orientation. Mining Engineering. Electrical Engineering. EE Bias Power. Engineering Control Orientation. EEand Electronics Trends.<br><br>Mechanical Engineering. Trends in Mechanical Engineering. Thermal Installations. Mechanical Engineering Oriented Manufacturing. Fluid Mechanics and Heat Trends in Mechanical Engineering. Mechanical Engineering Design Trends in Solid Mechanics.<br><br>Rangeland and Watershed Natural Resources trends. Natural Resources Engineering wood and paper. Natural Resources Forestry orientation. Mathematics and Applications. Theoretical physics. Nuclear Physics. Engineering and Construction of Railway Lines. Rail car engineering. Geomorphology. Statistics and Applications. Physics. Climatology. |
| **Art** | Architecture. Restoration and Rehabilitation of Historic Buildings. Crafts. Expert Carpet. |
| **English Translation of foreign languages.** | English language. English Language and Literature. |

Source: BSC (2012), summarised by Mehr News (2012).

When this booklet was discussed in the media, Seyed Abolfazl Hassani, a senior Iranian education official, claimed that:

> *Some fields are not very suitable for women's nature such as agricultural machinery or mining, partly because of the hard work involved in them. Past experience shows that women do not become professionally active in these fields after they are admitted to these subjects and even after they graduate. This results in the unemployment of graduates (Tabnak News, 2012).*

At this point, the Oil Industry University, which has several campuses across the country, claimed it would no longer accept female students at all because of the lack of employer demand (The Telegraph, 2012). Kamran Daneshjoo, the Minister of HE in Iran, then declared that this plan to reduce female candidates had been implemented by most of the universities identified and that, although they were allowed to regulate their own rules regarding admissions, he strongly recommended the change as necessary to create 'balance' in the labour market (Tabnak News, 2012). Thus, the 2012 HE's guideline involved the Ministry granting permission to universities to allow them to regulate their own rules regarding the reduction of women on certain courses but with a strong suggestion that they follow its guidance.

International scholars have suggested different reasons as to why this booklet was introduced by the Ministry of HE. Sahraei (2012) argues that "the Iranian government is using various initiatives… to restrict women's access to education, to stop them being active in society, and to return them to the home" (BBC Persian, 2012). According to Esfandiari (2012), the increasing number of divorces and decreasing number of marriages and births could be a possible reason behind this decision (ibid). In 2011, Iran reached a rate of divorce that was higher than the rate in Spain, Italy, and Ireland, and was unique among western Asian countries (Aghajanian et al., 2013). Here the assumption was that increases in the number of educated women in Iran created tension/conflict in the power relationships between men and women which had led to an increase in divorce rates. The increasing divorce rate and number of women in HE was perceived to reflect deeper and more likely permanent changes in the traditional family and patriarchal structures in Iranian society (Lutz et al., 2010). On the other hand, fears over high unemployment levels were also presented as the primary reason. This was noted by Khandan (2012)

who argued that a high number of female graduates threatened male workers who were seeking a job in the labour market (BBC Persian, 2012).

From the arguments above, both the concepts of patriarchal norms (manifest in assumptions about gender relations in the home) and human capital (evident in concerns about who can access the labour market) overlap with one another. Hence, we can argue that there are complex notions and tensions regarding gender in operation in Iran with a key tension between a dominant hegemonic discourse of male dominance but also debates around human capital and the needs of the labour market (historically driven by the loss of human capital as a consequence of the Iran-Iraq war). Considering this, this study aims to investigate female students' experiences of studying STEM[1] subjects at university. In doing so, I seek to identify how shifting cultural, political and economic attitudes towards women in STEM in Iran are manifest in female students' explanations of their experiences and decision-making. This study approaches policies such as those related to the 2012 restrictions holistically, recognising them as situated in an ongoing process of policy change and formation. In the past thirty years, "the policies towards women and their access to education have experienced several transformations" in Iran (Rezaei-Rashti, 2012, p.13). Therefore, the current position of women in engineering and mathematics cannot be fully understood outside of the socio-cultural and historical framework of changing political attitudes, which will be discussed in Chapter 2.

## 1.3 Why Focus on Mathematics and Engineering?

In recent years, researchers in western contexts have paid a great deal of attention to attracting women to the fields of mathematics and engineering (Blinckenstaff, 2005; Kuzmak, 2010; Solomon, 2012; Black et al., 2012; Mendick, 2005b). In many industrialised countries around the world, women are under-represented in STEM (Blinckenstaff, 2005). In the UK, for example, only 13% of students on engineering degrees are female (Engineering UK, 2015) and female participation in mathematics programmes is about 41% of all students enrolled (WISE, 2016). However, this

[1] In Iran, mathematics counts as a basic science course and engineering belongs to technical and engineering science but in the UK both are in the category of STEM. Therefore, I used the term STEM thereafter as many studies in western contexts use STEM when discussing mathematics and engineering programmes.

pattern is somewhat different in some Middle Eastern countries. For example, in Kuwait women make up 60% of the engineering students at university (UNESCO, 2013) and, in Iran, female participation in mathematics forms 67% of the total number of students engaged in undergraduate study (Research and Planning in Higher Education: RPHE, 2012). Women have also outnumbered men in a number of non-technical engineering fields in Iran, such as chemistry engineering (67%), polymer engineering (63%) and textile engineering fields (70%) (RPHE, 2012). Although, women are still under-represented in some technical engineering subjects such as EEand mechanical engineering, where participation of women falls to 21% and 16% respectively (RPHE, 2012). Nevertheless, we can argue that the Iranian HE sector appears to have been successful at enabling women to access mathematics and engineering degree programmes, which are typically seen as male-dominated elsewhere.

However, even though the numbers of women studying engineering have increased, it has not always translated into more women in the labour market (UNESCO, 2013). As stressed previously in Section 1.2, in Iran, many female students who graduate from engineering programmes do not go into the engineering profession. In 2015, female participation in the overall labour market was 13.2 % in comparison with male participation which was 63.2% (Iran Economic Monitor, 2016). Therefore, there is an interesting paradox in Iran with high numbers of women studying STEM at university but low numbers participating in the industrial sector of the labour market. Apparently, it is this paradox which led to the introduction of 2012 HE guideline in order to increase the number of qualified men in the labour market.

As can be seen from the above discussion, there are two factors which make the Iranian HE context particularly interesting in terms of studying gender and participation on STEM programmes: 1) higher levels of female participation in STEM, particularly mathematics and engineering programmes and the failure of this to lead to employment; and 2) the 2012 HE guideline designed to limit this participation mainly in engineering. Beside these external factors, there are also personal reasons which have motivated me to choose this topic. In 2000 I enrolled as a mathematics student at a university in Iran. I had failed to achieve high enough grades in the HE entrance exam (Konkur) for engineering, which led me to enrol on

this (mathematics) degree programme as a second choice. However, I found mathematics to be an interesting subject and later I found that, in western contexts, mathematics is viewed as a prestigious subject undertaken by those considered to be 'bright' or 'clever' (Mendick, 2005a, 2005b). This challenged me to better understand students' reasons for choosing different STEM subjects in both western and non-western contexts. My reading of studies located in Western contexts (e.g. UK, USA, Europe, etc.) suggested there may be different beliefs about the subject which are culturally located. Whilst mathematics is seen as elite and for the privileged few (Gates, 2001; Stinson, 2004), this did not speak to my experience in the Iranian context. Therefore, I began to hypothesise two key areas of difference between Iran and the UK/USA literature: 1) the notion of mathematics male stereotype in relation to female mathematics students, which has been noted by the likes of Mendick (2005a, 2005b) and Solomon (2012), may not be evident in the Iranian context; and 2) mathematics is not seen as a prestigious 'gatekeeper' subject in Iran but instead engineering has higher status which is contrary to many western contexts. Thus, a combination of my previous experience in this area and the aforementioned contextual factors (policy and participation patterns) has led me to see women's inclusion/exclusion in mathematics and engineering courses as an area where there is a serious need for qualitative research.

## 1.4 Who am I and Why am I Doing this Research?

This research is highly personal to me and I have sought to recognise my own positionality throughout the thesis (see Chapter 5) as both a strength and weakness. Here I provide an account of my own personal history in order to make this positionality clearer but also to explain why I have undertaken research on this topic.

I am a woman who has grown up and been educated in Iran in the post-revolution era (1979 onwards). During elementary school, we were exposed to what was termed as a new teaching context based on Islam and which was seen to empower the country and provide us with a new future in Iran. We were considered as the 'generation of war' due to the ongoing Iran-Iraq war which had significant economic consequences on the quality of education available. The end of the war in 1988

opened the way to an age of hope, where we were encouraged to imagine and view a new country.

When the war finished in 1988, I had almost completed elementary school. As I grew older and entered my teenage years, I experienced typical adolescent tendencies towards rebellion which meant not conforming to school rules and family norms and expectations. For these reasons, I questioned many things in Iran, including gender discrimination. As a consequence, I experienced some troubles with my school and family, such as not wearing proper school uniform and not attending classes, which resulted in me being dismissed from government school and having to go to a private school. At high school, I selected a mathematics and physics programme (the structure of the Iranian education system is explained in Chapter 2), because I had an ambition to study engineering at university. However, as noted above, my performance in the university entrance exam did not meet the criteria for engineering and I ended up studying mathematics as a second choice which required lower grades. Although I was not able to study engineering at a prestigious university which was slightly disappointing, I consoled myself with the fact that I still had a university place. My time at university changed my whole life since I lived in accommodation shared by six others girls who all had the same feeling of escape in relation to being at university. University gave us freedom which we never had experienced before: we could go out together, we could travel together and we could laugh together. I enjoyed every second of it and I benefitted from this space where I could be creative, discuss different issues with my friends, and reflect on my emotions and those of others.

After completing my undergraduate degree in Iran in 2004, I moved to the UK in order to access better postgraduate education but with a negative feeling about leaving my country behind. At that moment, I faced a new context, a new college (I had enrolled on a master's degree in finance) and no friends. I could not easily adapt to this new environment, my English language was very poor compared with others, and I started to feel the sensation of not belonging. I attempted to leave these feelings behind by learning English and trying to adapt myself to a new culture. As a means to understand my experience and decision to move to the UK, whilst simultaneously negotiating this sense of not belonging, I started to question 'what

makes a country successful', since accessing better educational and employment opportunities had been a key motive for my migration from Iran to the UK. This process started with understanding the 'economy of oil dependency countries' and my master's thesis in finance focused on this topic.

Although the key motivation in choosing this topic for my PhD was the introduction of 2012 HE guidelines referred to above, by pursuing this PhD I hope to identify strategies which can help to encourage female students to pursue careers in mathematics and engineering as a mean to support progress both in terms of gender relations in Iran and also the development of the economy and society more broadly. This research can help to give a clearer account of the positions women are offered/take up in Iranian society in a way that raises potential tensions and contradictions to consciousness. By doing so, I hope to identify spaces where women are able to exercise agency and freedom in their decision-making regarding their future trajectories. It is also possible that the narratives of female STEM students in Iran can offer insights into how we may tackle gender inequalities regarding access to STEM subjects at university level in other contexts, particularly in the UK or US where there are significant issues regarding recruitment of female engineers.

## 1.5 The Structure of the Thesis

This thesis is structured into three parts: the first part explains how the focus of the research is derived from the tensions and conflicts inherent in the Iranian context and existing literature on participation and access to STEM subjects at university. This explains why this research needs to be done and also notes my intention to apply a cultural-historical lens to the study, so that I am able to reflect on how the socio-cultural circumstances shape female students' perceptions of their experience of studying STEM degree programmes. This part of the thesis will also consider the relationship between western and non-western literatures on female participation in STEM. Chapter 2 begins with an overview of Iranian educational context after the revolution in 1979 and briefly explains the impact of Iran-Iraq war on Iranian women. It also describes the positioning of women in Iranian society and how this reflects different political attitudes across history since 1979. Finally, it considers women's access to HE and demonstrates increases in the number of women in

different fields of study. A key purpose of this chapter is to show that Iran is an interesting context to do research on gender and participation in STEM but also to provide an insight into the structural tensions in Iran which I will look for in my research.

In Chapter 3, I present an overview of broader literature on access to STEM through a discussion of the different arguments which have been presented to explain the relationship between gender and participation, most typically seen as low participation of women STEM in western contexts. Here, I argue that, in order to fully understand female students' participation and identification with STEM, there is a need to move towards a more complex idea of what gender is and to recognise gender as framed in relation to particular social backgrounds and religions. Therefore, I move towards considering the intersectionality of gender with other factors like class, religion and ethnicity, which I argue should be recognised in studying how gender is relevant to students' experiences of STEM subjects. The purpose of this chapter is to demonstrate that gender is a complex cultural phenomenon which requires an in-depth understanding of the local context in order to fully understand how it is experienced by students studying STEM programmes.

The second part of this thesis focuses on the development of the RQs and the overall design of the research. In Chapter 4, I present the theoretical framework for the study by providing an account of the theoretical concepts used to read the data. This focuses on Holland et al.'s (1998) work on identity and agency in cultural worlds and Bourdieu's social theory of praxis. The purpose of this chapter is to explain my reading of the key concepts and how they will be operationalised in the study, but also how they have been used in previous literature on gender and STEM participation. In Chapter 5, I present the epistemological basis for the study which is derived from my theoretical framework, and I argue for the relevance and appropriateness of narrative inquiry as a methodological standpoint. This chapter also provides an account of the overall research design which includes an explanation of the location of the study, the sample size and how participants were recruited, the methods of data generation, and also the ethical issues associated with doing this research.

The third part of this thesis reports on the findings of the research and is comprised of four chapters designed to address the RQs directly. Chapter 6 presents a full narrative analysis of one mathematics student, Zahra. In doing so, it highlights how her mathematics identity is constructed through the narrative utilising cultural resources from past, present and future. Chapter 7 shifts to discuss themes and patterns which emerge from across the narratives and looks to compare how mathematics and engineering identities are narrated. Here, I emphasise how engineering is viewed as a form of capital to the women in this study which they either align or misalign with. Its status as a form of capital is understood through the perceived opportunities it provides both locally and globally. Chapter 8 (moving abroad) then builds on this to explain how engineering students aspire to use such capital in order to move abroad and thereby overcome structural contradictions which arise between their gender and their degree/career field. Chapter 9 (discussion chapter) discusses the findings of the research in relation to a number of themes which directly answer the RQs. These themes are: 1) An engineering degree as a form of capital; 2) The role of family in choosing to study STEM; 3) The role of Konkur in choosing to study STEM; 4) High aspirations; 5) Contradictory discourses; and 6) Improvisation with capital. This chapter also provides an account of how the findings add to existing literature regarding gender in relation to participation in STEM but also considers how the research expands theoretical understandings of agency and capital to incorporate a more globalised notion of context when considering the local production of an identity and capital exchange. Finally, Chapter 10 is a short conclusion chapter which outlines the implications of the findings and gives recommendations based on the findings in terms of addressing issues of gender inequality in relation to STEM. Given the focus of this research and its emphasis on structural inequalities, it is difficult to make recommendations designed to change practices at a local level. Therefore, I will focus on the implications for future research and how the findings might be used in other contexts. This chapter will also address the limitations of this study.

## 1.6 Conclusion

To conclude, I have conducted this study to explore how the structures of Iranian society are manifest in female students' decision-making and aspirations in relation

to STEM, particularly mathematics and engineering. In this chapter, I have highlighted the value of addressing this topic in the Iranian context which arguably contains many tensions and conflicts. By using narrative inquiry, I argue that I am able to give a voice to the experiences of the women who participated in this research and it is hoped that I do justice to their accounts. Whilst my own experience of studying mathematics was in some ways transformative, I anticipate that this may not be the case for all of those involved in this research. Therefore, I hope to convey the diversity of experiences which have been conveyed to me in these women's narratives. Next, I explore the social and cultural context of Iran before moving on to outline how the Research is situated in the literature on STEM.

# Chapter 2: Situating the Study in the Iranian Context

## 2.1 Introduction

The overall purpose of this chapter is to demonstrate that Iran provides an interesting context to look at women's participation in engineering and mathematics, as there are contradictory discourses or ideologies at play. In order to set up my argument (that this contradictory social, cultural and historical context is manifest in the choices, experiences and aspirations of female students studying engineering and mathematics) I will provide a comprehensive account of the Iranian context for the reader who may not be familiar with it. First, I provide detail on the economic profile of Iran in order to understand the social status of STEM careers in Iran (specifically engineering) and as a programme of study in university. In addition, information on labour market trends including female participation will also be provided. Secondly, commonly accepted notions regarding social class divisions and the structure of Iranian society will be described and this is relevant since previous literature suggests that intersections of class and gender are significant in shaping female students' relationships with STEM subjects (Choudry et al., 2017; Black et al., 2011; Shaw et al., 2010). Thirdly, the structure of the education system will be explained in order to familiarise the reader with the system that the students have experienced. I then follow this with some explanation of how women are positioned within educational policy and in the Iranian education system more generally. In doing so, I will consider how policies have fluctuated over the past thirty years in terms of how they position women in Iran. I will show how such policies are rooted in particular ideologies regarding gender and the state which, arguably, reflect a dynamic process of modernisation and de-modernisation which has taken place over the past 30 years. Therefore, I will discuss espoused beliefs regarding the socio-economic history of Iran during this period to explore the apparent 'need' for women engineers in the workforce, but also why it apparently no longer needs them according to the government HE guidelines referred to in Chapter 1. Finally, the contradictions apparent in Iranian society in terms of developing women's roles (e.g. as a form of human capital and housewives simultaneously) will be explained.

## 2.2 The Structure of the Economic System

Iran's economy is typically viewed as dependent on natural resources such as oil and gas or, in other words, Iran is considered an oil dependent country. According to UNESCO (2013), Iran's oil and natural gas reserves are a main source of national revenue: "On average, 60% of the Iranian government revenues and 90% of export revenues originate from oil and gas resources" (Farzanegan, 2011, p.1055).

However, according to Bertelsmann Stiftung (Iran Country Report) (2016), Iran is attempting to transform from a natural resources-based economy towards a knowledge-based economy which is about developing human capital mainly in the area of science, technology and innovation. "Since, 1990, Iran's economic plans have emphasized a gradual move towards a market-oriented economy and development of the private sector" (UN, 2005, p.7). Therefore, Iran's apparent dependency on oil has eroded over time and, in recent years, the dominance of the service sector as a proportion of GDP (or in employment rates) may now mean that Iran's economy is a service-based economy.

> *The Economist Intelligence Unit' reports that 48.5% of GDP belong to the service sector and 41.3% belong to the industrial sector and 10.2% of GDP belong to the agricultural sector (UNESCO, 2013).*

This is confirmed by the National Statistics Centre which indicates that the share of the service sector in the labour market has increased in recent times and reached 48.7% in 2012 (Hashimi et al., 2012). This sector includes: public services, financial and administrative services, social services, and health care services (ibid).

In 2015, President Hassan Rouhani announced that the "economic strategy of significantly reducing Tehran's dependency on oil has started to bear fruit" (The Guardian, 2015), a position which is widely assumed to be motivated by the fall in oil prices and pressures of increased sanctions on Iranian exports (The Guardian, 2015). Farzanegan (2011) noted that "recent international pressures through different economic sanctions due to the Iranian nuclear program have tried to limit investment possibilities in the energy industry of Iran, restricting Iranian oil exports"

(Farzanegan, 2011, p.1068). As a result, a key argument from the Iranian state is that it has needed to develop human capital mainly in the service sector in order to overcome restrictions on exporting oil due to such sanctions.

Nevertheless, the historical emphasis on oil has generated a perceived need for engineers, and may explain the high demand and status of engineering as a career in Iran (which will be explained shortly). Arguably, this economic history has influenced the creation of an education system designed to produce more engineers, emphasising or valuing mathematics and physical sciences over humanities (explained more in Section 2.5). However, there are fluctuations in the economic demand for engineers which has also impacted policy decision-making as highlighted below.

## 2.3 The Participation of Women in the Iranian Workforce

In general, studies have shown that the participation of women in the Iranian labour market is dramatically lower than men (Iran Economic Monitor, 2016). Table 2 below shows the total percentage of males and females in the Iranian labour force from 1956 to 2016. As can be seen, from 1976 to 1986 the percentage of working women had declined from 15% to 10% (after the Cultural Revolution), but it has been rising again since reaching 15% in 2006 and 2016. According to Moghadam (2009), this rise in female workers after 1986 could be a result of increasing numbers of female graduates. Table 3 outlines the number of female workers in different sections of the economy and shows a dramatic drop in participation rates of female workers in agriculture, from 27% in 1986 to 17% in 1996, and then to 14% in 2006. This could be the result of industrial mechanisation that occurred in rural areas (Moghadam, 2009). In the case of urban areas, in 2006, about 13% of the female population of ten years and older were active in the economy (ibid). However, we should note that there is a possibility of a considerable undercount of urban female workers who are engaging in the informal economy (Moghadam, 2009). According to Ranani (2001), "the combined informal work of male and females may account for up to 50% of the total active labour force, with a rising female share" (cited by Moghadam, 2009, p.89).

The informal economy in Iran refers to labour such as working in small private companies, producing ordinary goods and working voluntarily (Povey, 2010). A large number of female 'home-based' adults are also working in the property sector and money markets which are part of what is classified as informal employment (ibid). This indicates that people engaged in the informal economy are not necessarily from the lower socio-economic classes (ibid). Therefore, women of different classes work a large number of hours which are not officially recorded in employment statistics and, therefore, their productivity value is unidentified (ibid). Moghadam (2009, p.81) notes that "this finding is in sharp contrast to studies in other developing countries in which informal participants are generally poor and unskilled and are unable to join the modern formal economy".

Table 3 also reports gender differences in the industry sector of the labour market, which again shows there has been a drop in the participation rate of female workers: 33% in 1996 to 23% in 2006, with this figure remaining almost the same (25%) until 2016. The findings from this particular sector are of interest to this study, as they indicate that despite increasing numbers of women enrolling on to STEM programmes at university, their participation in the labour market is static, thus suggesting a potential contradiction between education and employment in the Iranian context (discussed in Section 2.7).

Therefore, like many other Middle Eastern countries, Iranian employment statistics indicate the dominance of men in the labour market. Throughout this thesis, I will suggest this is indicative of the patriarchal structure of Iranian society, whereby many women do not have access to or are not expected to occupy formal employment positions. However, the evidence I will review shortly also indicates that cultural expectations regarding female employment and education are complex and depend on intersections of class and gender. Next, I move on to discuss the socio-economic structure of Iranian society in order to support an understanding of how gender and class might intersect in this context when considering participation in mathematics/engineering and STEM more broadly at university.

**Table 2:** Active population ten years and older (%)

| | 1956 | 1966 | 1976 | 1986 | 1996 | 2006 | 2016 |
|---|---|---|---|---|---|---|---|
| Male | 90 | 87 | 85 | 90 | 87 | 84 | 64 |
| Female | 9 | 13 | 15 | 10 | 13 | 15 | 15 |
| Total | 100 | 100 | 100 | 100 | 100 | 100 | n/a |

Sources: ILO, Yearbook of Labour Statistics (Geneva, 1967), 20; (1971), 28; (1982), 23; (1992), 31; Markaz-e Amar-e Iran (1997): 109–111; (2004): 90–93; Statistical Center of Iran, http://www.sci.org.ir/portal/faces/public/ census85/census85.natayej, Published by Moghaddam (2009, p.85) and Statistic center of Iran (2016).

**Table 3:** Distribution of employed women by economic sectors ten years and older (1,000 persons)

| | 1976 | | 1986 | | 1996 | | 2006 | | 2016 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Total | % | Total | % | Total | % | Total | % | Total | % |
| Total | 1212 | 100 | 975 | 100 | 1765 | 100 | 2782 | 100 | n/a | 100 |
| Agriculture | 228 | 19 | 259 | 27 | 294 | 17 | 401 | 14 | n/a | 22 |
| Industry | 639 | 53 | 211 | 22 | 583 | 33 | 651 | 23 | n/a | 25 |
| Public, social and private services | 287 | 24 | 414 | 42 | 810 | 46 | 1552 | 56 | n/a | 53 |
| All other groups | 58 | 5 | 91 | 9 | 78 | 4 | 178 | 6 | n/a | n/a |

Notes: In each of the economic sectors included in this category, women's participation is less than 2% of the total. However, the category "activity not classified" accounts for 4.6% and 2.9% of the total for 1986 and 1996, respectively.
Source: Markaz-e Amar-e Iran, 1997: 112–113; http://www.sci.org.ir/portal/faces/public/census85/census85.natayej. Published by Moghaddam (2009, p.86) and statistic center of Iran (2016).

Iran is a country which is typically viewed as comprised of different traditional cultures, customs and ethnic groups (UNESCO, 2013). It is a country with diverse range of origins such as the Persians (50%), the Azeri, Turks (20-25%), the Kurds (10%), and the Arabs (3%), as well as the Lors, the Turkmens, and different tribes such as the Baluchis and the Ghashghaees (UNESCO, 2013, p.13). The formal and

main religion is Shia Islam (around 85-90%), with other religious groups like Sunni Muslims (around 5-10%), and Zoroastrians, Christians and Jews (around 0.1 - 0.5% each) (ibid).

Iran's population doubled after the 1979 Cultural Revolution due to a dramatic growth in the birth rate during the 1980's (ibid). However, this trend changed in 1990 as the government implemented measures to control population growth by promoting family planning (ibid). According to Vahidnia (2017, p.259) "Iran has experienced one of the most successful family planning programs in the developing world, with a 64 percent decline in total fertility rate (TFR) between 1986 and 2000". As a result, Iran is typically viewed as a young country with 50.2% of the population (78.1 million) aged below 25 (Iran Country profile, 2016). Therefore, finding jobs for young people is often presented as a key economic issue for Iran (UNESCO, 2013).

Furthermore, Iran has experienced an increase in participation in HE which is perceived to have produced a more educated workforce. Table 4 below shows the unemployment rates by education and by gender for those under 30 years old. Here, we can see that, between 2006 to 2011, the number of unemployed adults has increased amongst both men and women across the board, but particularly amongst those with higher levels of education and especially amongst educated women. This corresponds with the evidence in Table 3, where the number of female workers in many areas of employment is shown to have decreased. Regarding this pattern of increasing unemployment, Isfahani (2013) notes that:

> *The future is not likely to be a whole lot better for the university-educated. If the current economic slump ends, we could go back to the unemployment rates of 2006, but at the rate at which post-secondary education has been expanding in Iran, I would expect that educated youth unemployment will continue to be a serious problem at least until 2020 (p.10).*

Isfahani (2013) also connects the problem of youth unemployment to the economic sanctions Iran has faced and suggests that resolving this issue may help to improve youth employment rates:

> *The big unknown on the demand side of the labour market is the economy's ability to resume growth rates of 5-8%, which are necessary to absorb the flows of new workers into the labour market and to chip away at the 4-million strong stocks of the unemployed. Any economic growth in excess of 5% over a number of years would require the end of the international sanctions (p.12).*

However, we should note that concerns regarding increasing levels of unemployment among educated people are not only a focus for Iran but also the entire Middle East and North Africa (Isfahani, 2013).

**Table 4:** Unemployment rates by level of education for those under 30 years old

| | Men (%) | | Women (%) | |
|---|---|---|---|---|
| | 2006 | 2011 | 2006 | 2011 |
| Less than primary | 19 | 21 | 30 | 26 |
| Primary | 18 | 22 | 32 | 32 |
| Secondary school | 24 | 29 | 51 | 51 |
| Some college | 27 | 26 | 47 | 48 |
| University | 22 | 35 | 36 | 49 |
| Graduate school | 16 | 29 | 22 | 44 |
| Total | 21 | 25 | 41 | 45 |

Sources: Statistic center of Iran, cited by Isfahani (2013, p.10).

Growing unemployment is also identified in the literature as a causal factor in explaining increased migration from rural areas to the cities from 1990 onwards "causing dramatic urban development pressures" (UNESCO, 2013, p.13). According to UNESCO (2013, p.13), the "Urban population increased from 45.7% in 1975 to 66.9% in 2005 and is expected to reach 71.9% in 2015". Statistics released by the World Bank have been used to demonstrate the validity of this prediction, and in 2015 they announced that urbanisation in Iran had reached 72.9% (Bertelsmann Stiftung, 2016). Lack of facilities and high unemployment in rural areas are said to

have increased migration to cities (urban areas), resulting in higher urban unemployment rates, over-crowding and homelessness.

One reason for this may be that competition in the agricultural sector has made life in rural areas very difficult. UNESCO states that those living in rural areas "face competition from imported cheaper agricultural goods, worsening ecological conditions and natural disasters threatening their livelihoods" (UNESCO, 2013, p. 17). Some rural areas are located in places that are very remote and are "well behind the national average in terms of human development and lack of access to basic health and education services" (ibid) which, arguably, produces some social disparities in Iranian society (between rural and urban social class positions). However, Iranian urban areas are also stratified by some major socio economic differences resulting in an urban class system. Below, I discuss such divisions further.

## 2.4 Socio-Economic Class Divisions

According to Nomani et al. (2006, p.121), "class and gender are both systems of inequality, or divisions reflecting the interaction of economic and patriarchal relations along gender lines". There are six different groups which I have identified through my reading of the literature on Iranian society which can be established as socio-economic classes: Ulama, modern capitalist, traditional capitalist, traditional middle class (petty bourgeoisie), modern salaried middle class, and working class. Clearly, the term 'socio-economic class' is a highly contested term and has diverse meanings in the research literature. Here, I attempt to offer a definition that relates to the Iranian context, which must acknowledge not only financial status, but also cultural and religious status which is central in the relationship between class groups that are dominating and those that are dominated (following Bourdieu's work on class position – see Chapter 5).

The Ulama or Mollah are the group of people who study the Shia Islam religion and they are members of the judiciary, government and any other top decision-making position in the country (Moaddel, 1993). "Their positions give them significant

material wealth as well as social prestige and political power, and they have been an integral part of the policy in procapitalist Iran" (Moaddel, 1993, p.131).

The second and third class groups consist of 'capitalists' (modern and traditional). According to Behdad et al. (2009), capitalists control the labor force in Iran (as in other countries) as they possess the physical and financial resources to produce economic activities. Behadad et al. (2009) divides Iranian capitalists into modern and traditional occupational categories giving the definition of each below:

> *By modern subcategories of occupations we mean capitalists whose occupational locations are managerial administrative or professional-technical. These are the occupational locations of capitalists in the modern firms of the more advanced industrial economies. Traditional capitalists are those in clerical, sales and service, agricultural, or production occupations (p.81).*

Besides capitalists, the literature also indicates two different kinds of middle class in Iran. According to Moghadam (2003, p.17), this reflects the situation in many Middle Eastern countries which contain "a traditional middle class of shopkeepers, small bazaaris, and the self-employed - what Marx call the traditional petty bourgeoisie". In Iran, people belonging to the petty bourgeoisie's class contain those working in "metalworking crafts, woodworking crafts building and ceramic crafts, textile and leather crafts, food-treating crafts, and retail traders" (Moaddel, 1993, p.100), as well as "teahouse workers, ice cream sellers, shoe makers, cloth sellers, tailors, builders and similar occupations" (Moaddel, 1993, p.117). The second type of middle class is a more modern salaried middle class and includes people working for the government sectors or in the private sector as "teachers, lawyers, engineers, administrators, secretaries, nurses, doctors, and so on" (Moghadam, 2003, p.17).

In addition, Moaddel (1993) suggests the first core of the Iranian working class was initially shaped between the late nineteenth and early twentieth centuries. When oil was first founded in Khuzistan in southwest Iran and when an oil refinery in Abadan was established, the first Iranian working class system is seen to emerge (ibid). In more recent years, the working class group is purported to contain Industrial workers (factory workers) such as mechanics, (carpet) weavers, turners and welders,

construction workers and traditional workers such as tailor workers, (cab) drivers, dry-cleaner workers, porters and servants (ibid).

The espoused discourse of Iranian social class divisions I have presented here is significant, as it informs my developing story about how Iranian society understands gender, and particularly the positions and roles women occupy in Iranian society. This will be discussed in detail in Section 2.6.1, but here I would like to point out that attitudes towards women studying at university have changed in the post-revolution era across Iran, particularly in the middle class and capitalist social groups. There is also a visible section of civil society aimed at empowering women which is largely active in urban areas. The changes in attitudes towards the education of women are apparent even in religious groups like the Ulama class and, therefore, it is important that the reader does not make the assumption that religion and feminism are mutually exclusive in Iran. Najmabadi (2000) criticises such beliefs with emphasis on the historical specificity of Iranian nationalism, feminism, modernity and secularism, stating that:

> *Thinking about Islam as the antithesis of modernity and secularism forecloses the possibilities of recognizing these emergences and working for these reconfiguration; it blocks off formation of alliances; it continues to produce Islam as exclusive of secularism, democracy, and feminism, as a pollutant of these projects; and it continues the work of constituting each as the edge at which meaning would collapse for the other (Najmadabi, 2000, p.41).*

In this respect, Hashimi et al. (2012) argue that an ideology change regarding 'educated Muslim women' has taken place in Iran. This can be seen in a shift in attitude by the religious authorities who granted permission for women to enrol in university after the Cultural Revolution in 1979. But such a change is also thought to be shared by the middle classes also who have become eager to send their daughters to university (ibid). This shift in attitudes is linked in the literature surrounding Shi'i ideology which underpinned the Cultural Revolution. For instance, Moaddel (1993, p. 99) argues that "it was Shi'i revolutionary discourse that shaped the action of the member of these classes in a revolutionary direction". In this respect, the feminist movement which has promoted women's empowerment through education is considered to have had a substantial impact across multiple social groups in Iranian

society. As Nomani et al. claim, "because class is a multidimensional social phenomenon, therefore, we recognize the importance of the role of human consciousness and all form of action in class and gender" (Nomani et al., 2006, p.121).

The participants in my study largely come from families who can be identified as being part of the modern salaried middle class (with the exception of one participant, Sarah, who's family are considered to belong to the Ulama class). In later chapters, I explore how their class position (in relation to the structure outlined above) can be seen in their narrative interviews and how shifting attitudes towards female education (outlined in Section 2.6) are evident. Next, I explain the structure of the Iranian education system in order to provide more detail on the cultural context which frames women's access to STEM programmes in university in Iran.

## 2.5 Structure of the Education System

Education in Iran consists of two levels: K-12 and higher education. K-12 includes grades 1-12 which are divided into four parts: Primary school (Dabestan), Middle school (Rahnamayi), Secondary school (Dabirestan) and Pre-University education (Arani et al., 2012)[2]. Middle school, also known as the guidance cycle (Rahnamayi), is from the sixth to the eighth grade (3 years) and provides students with a general education but also guides them towards choosing a particular track for Secondary school (Arani et al., 2012). Secondary school (Dabirestan), covers three years and is divided into two major divisions: theoretical/academic studies and vocational/technical studies (ibid).

The theoretical or academic branch contains four subject areas: mathematics science, humanities science, experimental science and economic branches (Arani et al., 2012). The technical-vocational branch is more occupational in structure and includes three parts: technical, business and agriculture (ibid). Students are required to choose their preferred track of study at secondary school (secondary school)

[2] At the time when the participants are studying, this is how the education system works.

during their first year. Students must complete 96 units in the three years that they are in secondary school in order to be awarded the Secondary school diploma (Diplome Mottevasseteh) (Mehran, 1992). Pre-University education occurs after this as a one year course for students who wish to enter to university and prepare them to sit for the national entrance exam (Konkur) (ibid). Technical-vocational students may either join the labour market or continue on to a higher institute of technology or technical-vocational teacher training centre (Mehran, 1992, p.10). "Technical-Vocational HEis mostly provided by the centers affiliated to the Ministry of Education" (National Report of HE, (NRHE), 2010, p.7).

Table 5 below presents the different stages of education before university and Table 6 demonstrates the percentage of female students participating in education at each level (the data refers to the ratio of girls to boys). Table 6 shows that the percentage of female students enrolled at school has increased at the pre-primary and primary level from 2000 onwards (Rezaei-Rashti, 2012), presumably in response to the UN Millennium Development Goal of universal primary provision. However, between the years 2005 to 2010, the number of girls in secondary and tertiary education in relation to boys has declined (Rezaei-Rashti, 2012). The reduction in tertiary education could be "a result of some regressive policies that the Ministry of Health put in place to limit the percentage of women entering medical fields and postgraduates studies" (Rezaei-Rashti, 2012, p.5).

**Table 5:** Different level of education in Iran

| Age | Level of education | Duration in years | Remark |
|---|---|---|---|
| 5-6 | Pre-primary (Kindergarten) | 1 | Optional |
| 6-11 | Primary (Dabestan) | 5 | Compulsory |
| 12-14 | Guidance cycle (Rahnamaye) | 3 | Compulsory |
| 14-17 | Secondary education (Dabirestan) | 3 | Optional |
| 17-18 | Pre-University | 1 | Optional |

Sources: Arani et al., (2012, p.3).

**Table 6:** Iran (Islamic Republic) Female students' participation at different academic levels (2000, 2005, 2010)

| Year | | 2000 | 2005 | 2010 |
|---|---|---|---|---|
| Pre-primary | Total number | 125856 | 256820 | 234365 |
| | Percentage | 50% | 52% | 51% |
| Primary | Total number | 3938766 | 2991211 | 2930152 |
| | Percentage | 47% | 48% | 49% |
| Total secondary All programmes | Total number | 4703729 | 4357512 | 3648542 |
| | Percentage | 47% | 48% | 45% |
| Total tertiary | Total number | 635973 | 1083664 | 1061990 |
| | Percentage | 45% | 51% | 49.5% |

Source: UNESCO (2012). Data centre. Retrieved September 27, 2012, from stats.uis.unesco.org/unesco/TableViewer/tableView.aspx (cited by Rezaei-Rashti,2012, p.6).

There are both free public schools and private schools in Iran at all levels, from primary school through to university (Arani et al., 2012). Both public and private sector universities require Konkur (national exam*)* for entry. The exam covers common secondary school topics and takes place once a year in 5 different academic streams of "experimental sciences", "mathematics and physics", "human sciences", "fine arts", and "foreign languages" (Farrokhi-Khajeh-Pasha, 2012, p.1). Students opt in to their chosen stream at age 14 where they enrol on a high school programme which prepares them for the relevant entrance exam. Once they have received the results of their entrance exam, students select university courses relevant to their stream from a list distributed by the ministry of science, which can consist of up to a hundred majors (BSC, 2012).

Thus, students get their results from the national entrance exam first and then choose their degree programme. Entry onto engineering programmes can only be attained by those who have passed the mathematics and physics entrance exam and this requires a higher mark than other degree programmes. Thus, engineering has a high exchange value in Iran and, for many mathematics students, engineering is normally their first

choice of subject (BSC, 2012). Science courses such as mathematics and physics require a lower mark and are normally considered a backup option if students fail to get onto engineering programmes. Students who cannot get any place at university have the opportunity to re-take the exam in the following year. Previously, the private and public university systems in Iran had separate entry qualifications but, in 2013, this was abolished and now both systems use the same entry exam (the Konkur).

In 1979, by establishment of the Ministry of Culture and HE (MCHE), all HE institutions, public and private, followed the same administrative structure, consisting of a board of trustees, a chancellor, an executive board, an administrative board, a university council, faculty councils, and departments (Alashloo et al., 2005). Tuition fees for public universities are funded by the government, whereas the government does not help to pay tuition fees for private HE institutions (NRHE), 2010). Students who study at public universities are required to work for the government for a number of years, typically equivalent to those spent at the university, or they can choose to pay their debt off instead at a very low rate (typically a few hundred dollars) (Arani et al., 2012). Students who are admitted to university (either public or private) can study in only one of the following fields: Humanities, Basic Sciences, Engineering, Agriculture and Veterinary, Medical Sciences, or Arts (NRHE, 2010).

In Iranian HE, four levels of qualification are available: an associate's/post-diploma (two years), a bachelor’s degree (four years), a master’s degree (two years), and a doctoral degree (four years) (NRHE, 2010). The academic year starts in September and finishes in June, and contains two semesters (Arani et al., 2012). Students attend classes from Saturday to Thursday (ibid). Public universities offer two types of program: daytime or evening programmes, with the tuition fees for evening programs paid for by students themselves: "In order to meet the growing public demand for higher education, the facilities of the universities are mobilized to offer education in the evenings. The funding of this kind of education, called Evening Programs, is secured through the tuition fees the students pay"(NRHE, 2010, p.7). Demand for degree programmes in public universities is competitive in Iran, with limited places for candidates; public universities are more sought-after because they

are cheaper and their qualification is more recognisable. Public universities have higher rates of participation by female students when compared with Azad Universities (private). In public universities, women have increasingly outnumbered men since 2001 (from 50% in 2001 to 59% in 2010), whereas private universities has seen a small decrease in the numbers of women enrolled (from 48% in 2005 to 40% in 2010) (Rezaei-Rashti, 2012). In the next section, I will give an account of how such patterns have occurred in Iranian HE.

## 2.6 Women, Education and HE in Iran

When the University of Tehran was opened in 1934, modernisation of the education system was gradually being introduced to Iranian society and women's participation in HE began to increase slowly (Rezaei, 2012). During the time of Reza Shah[3] (Pahlavi regime[4]), the government sponsored European education for many Iranian students (Jacqz, 1976). Reza Shah (1925-1941) is often presented as the father of modernisation in Iran, who changed Iranian society in many aspects such as politics, economy, industry and religion (ibid). For instance, the number of modern industrial plants increased 17-fold under Reza Shah, a national railway was constructed in this time and the oil industry started to run by Iranian technicians (Abrahamian, 1982). Along with the process of modernisation, Reza Shah apparently forcefully ordered women to take the Islamic veil off and allowed them to work in society alongside men (Mahdi, 2004). This time is typically known as a period of women's awakening because, for the first time in Iran, women were able to participate in many parts of society (1936–1941) (Afkhami, 2008). During this time, Iran is seen to have moved into the modern era with extraordinary speed (Jacqz, 1976); for instance, Tahmasebi (2011) argues that this was the point in time when Iran no longer belonged to the third-world nations.

After the cultural revolution of 1979, a new regime was established on the basis of Islam which is often presented as introducing limitations on any form of

[3] Reza Shah was the king of the Imperial State of Persia, from 15 December 1925 until he was exiled by the Anglo-Soviet (Britain and Russia) invasion of Iran on 16 September 1941 (Britannica, 2012).
[4] Pahlavi regime included two Iranian monarchs, the father and son Reza Shah Pahlavi (reigned 1925–1941) and Mohammad Reza Shah Pahlavi (reigned 1941–1979).

modernisation (Esfandiari, 2012). For example, commentators note the introduction of changes in the educational system including "transforming co-educational schools to single-sex institutions" (Rezaei, 2012, p. 395), compulsory veiling of girls from the age of 6 (Mehran, 2003), having Arabic as a second language, and rewriting textbooks from an Islamic perspective (Rezaei, 2012).

According to Afkhami and Friedl (1994), at a time when education systems in most countries were investing to produce a more skilled workforce, Iran's main educational aim was to develop individuals according to a model of 'a good Muslim' (Rezaei, 2012). According to this ideology, men and women were defined as two completely different sorts of people who are different in terms of physical ability and in terms of aspirations (ibid). This belief was reflected in Paivandi's (2008) content analysis of Iranian textbooks being used in 2007-08 which identified three issues (n.b. this analysis covered a range of subject areas such as Persian language, social sciences, history, science and religious studies which is covering all level of education from primary to secondary schools):

> *1. Women and men are not equal. Not only is this inequality clearly expressed, but the curriculum also seeks to justify this within an Islamic framework. The legal and social equality of men and women is not mentioned. 2. Women and men have assigned gender roles in their social and private lives and are presented as two different social individuals who complement one another. Men are defined as the "superior sex" and women are the "second sex". 3. In comparison with modern women—who have rights equal to men in all contexts—Iranians are faced with a de-modernised image, limited to the house and the boundaries of family life (p. 6).*

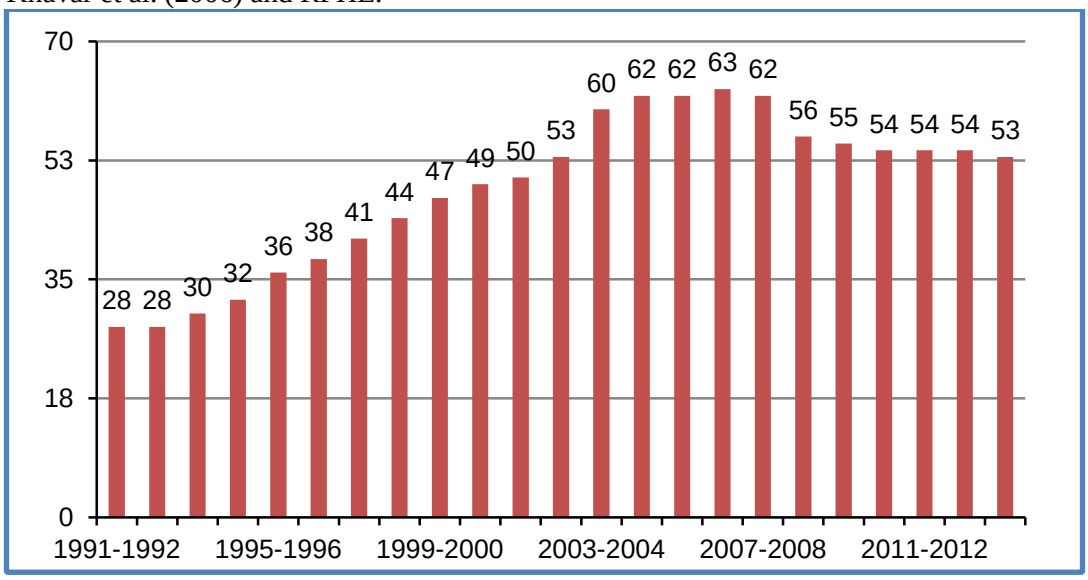
However, despite this apparent ideological standpoint of anti-modernisation, the number of women enrolled at university grew significantly. During this era, women have surpassed their male counterparts in terms of numbers enrolling in universities.

Figures 1 and 2 indicate the proportion of female students in Iranian HE (both private and public) from 1991 to 2014. Data gathered by Khavar et al., (2006) from 1991 to 2002 have been used here in addition to data from 2003 to 2014, calculated

from the Research and Planning in Higher Education[5] (RPHE). This information describes a pattern of increasing female participation in HE from 1991 till 2014. As can be seen from Figure 1, the increase in the number of women in university has risen from 1991 onwards: in 2006 the figure was 29% of all students enrolled (men and women) but reached 63% by 2014. Therefore, in 15 years, the proportion of women in HE has increased by 34%. In 2002, women outnumbered men for the first time in university and, since then, Iranian women have entered HE in larger numbers than men.

To put this into context, the number of male and female students enrolled at secondary school is approximately the same. In 2007, the male population in secondary school was 2046000, with the female population being 2070000 (Hashimi et al., 2012). Therefore, all things considered, we would expect there to be equal numbers of men and women entering universities (ibid). However, as mentioned above, the statistics show that there is no such balance in the university sector - in 2006-2007 63% (the highest average between 1991 to 2014) of university students were female (see Figure 1 below).

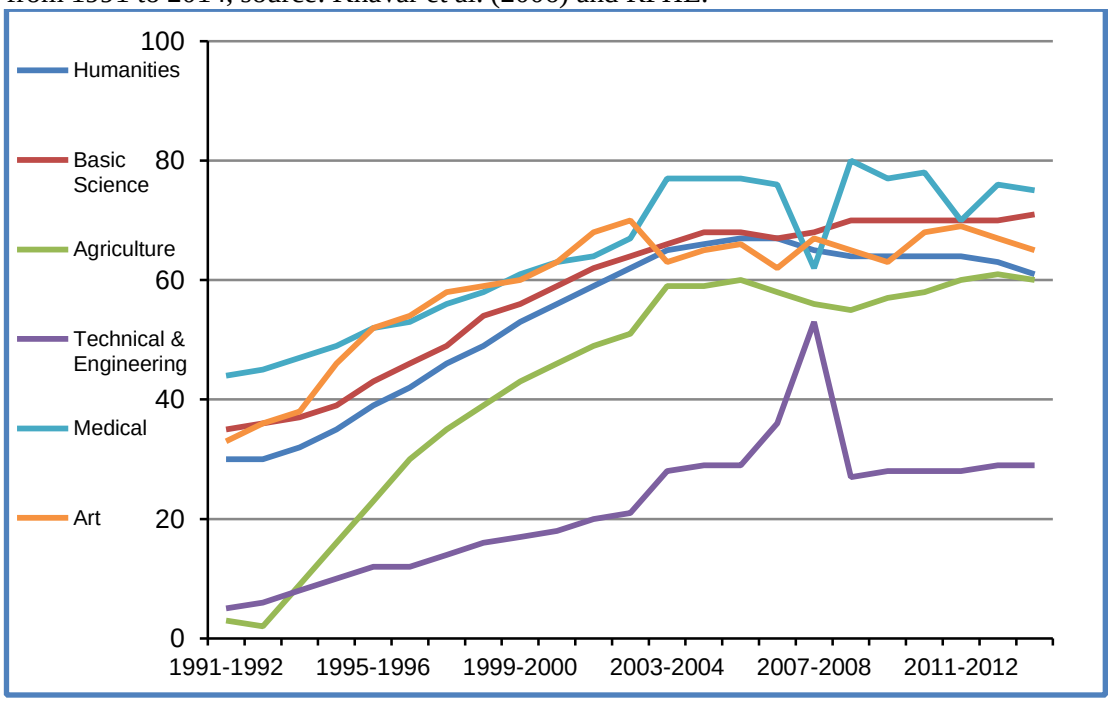
**Figure 1:** The participation of female students in Iranian HE from 1991 to 2014. Sources: Khavar et al. (2006) and RPHE.




[5] 'The Institute for Research and Planning in HE (IRPHE) is a dynamic, responsive and leading organization in theorizing, modeling and designing the advanced system proportional to Iranian society and culture in the field of planning of HE in regional level' (IRPHE, 2016).

Moreover, Figure 2 below presents the participation rates of female students according to field of study from 1991 to 2014. Here, we notice that, in 1991, the field of medicine was the most prominent subject for women to choose in university, with engineering and agriculture being the least popular fields. However, since this time, the rapid increase in female participation appears to be most considerable in the agricultural field, which increased from 2% in 1993 to reach 60% in 2014. Furthermore, in the technical and engineering fields, women's share of enrolment was only 5% in 1992, but reached 53% in 2007, although it did suddenly drop in 2008 to 27%. Therefore, female students have become more prominent in traditionally male-dominated courses such as agricultural fields, engineering and science fields including mathematics and physics (see Figure 2 below).

**Figure 2:** Changes in percentage of female participation rates in different fields of study from 1991 to 2014, source: Khavar et al. (2006) and RPHE.




Nevertheless, despite such evidence, there is insufficient research in Iran which examines why such increasing levels of participation are taking place and how this affects the experience and the future aspirations of students studying on such programmes. The research which does exist (Rezaei-Rashti, 2011, 2012; Rezaei, 2012; Mehran, 1992, 2003; Shavarani, 2006; Khavar et al., 2006; Hashimi et al., 2012; Paivandi, 2008) mainly observes the increase in female students in HE in

general and, therefore, does not focus on mathematics or engineering in particular. This creates a gap which my study aims to address by exploring the narratives of mathematics and engineering female students in Iran, and specifically their reasons for choosing these subjects.

In the following paragraphs, the cultural-historical structure of Iran after the revolution will be discussed in order to explain some of the dominant ideologies at work in Iran (both in society and in policy) about women and their role in society. I will argue that policy in particular has shifted from positioning women as form of desired human capital (specifically in STEM) towards what has been phrased as 'de-modernisation', where the traditional role of women as mothers and wives is emphasised. In doing so, we can see potential contradictions at play, whereby increasing numbers of woman are enrolling in HE, and particularly in STEM subjects, but there are lower numbers of female graduates employed in the labour market. Despite the increase in women in HE and in engineering and science/mathematics outlined above, there are much lower numbers entering the labour market in these areas and this is a contradiction, given a key function for HE is thought by some to be to develop human capital for the labour market.

### 2.6.1 Contradictions in the Position of Women in Educational Policy in Iran

According to Rezaei-Rashti (2012, p.13), "in the past thirty years, the policies towards women and their access to education have experienced several transformations". In order to understand such policy changes, I have classified the time post-revolution into four periods: 1) 1980-1987: traditional period; 2) 1987-1997: transitional period; 3) 1997-2009: modernisation period; and 4) 2009-2012: the resurgence of traditionalism. Whilst this classification draws on Rezaei-Rashti (2012), I have added my own interpretation of these time periods in order to relate it to the focus of this study on women and access to HE studying STEM subjects. This account is necessary in order to understand or contextualise the stories of the women in this study, and to better understand their account of the expectations placed on them in relation to STEM. The interviews for this study took place in the year 2015- and, for this reason, I do not provide an account of events which have taken place

since this date, on the basis that they could not have informed the women's narratives.

It should also be noted that, when I talk about the era of modernisation, I do not mean that there is no emphasis that women should take up traditional roles (e.g. as a good mother and wife), but rather the role of women as a form of human capital is also present in such policies. Furthermore, shifts in ideology and ideas around gender in policy are complex and I am not trying to present a distinct sequential shift from what I term as more traditional beliefs to modernised beliefs, as these two ideologies often appear side by side, resulting in contradictions such as that mentioned above. What I argue here is that, at certain points in time, there has been more emphasis on one than the other in educational policy.

#### 2.6.1.1 Traditional Period (1980-1987)

The first period I have defined is 'the traditional period' which centres around the conservative (Islamic) view of women. This period is typically presented as highly restrictive in terms of women's access to education (and particularly STEM) in HE, on the grounds that being educated in STEM subjects does not fit with Islamic teaching about women, what we might term as an Islamic fundamentalist position in which women only have one life trajectory which is to be as a good mother and wife.

After the Cultural Revolution, in what is seen as a means to implement traditional values (conservatism), universities were closed for about three school years (1980-1983) (Rezaei-Rashti, 2012). The government used this opportunity "to purge the universities of professors affiliated with the West or the East and turning universities to a healthy environment for flourishing of sublime Islamic Shiite sciences" (Rezaee, 2008, p.2). According to Menashiri (2001), Imam Khomeini represented a new Iran modelled on his idealistic design. Therefore, some commentators argue that a hundred years of secularisation and modernisation was removed from the Iranian education system during this period (Paivandi, 2006).

In relation to Higher Education, in 1984, when the universities re-opened, Khomeni's ideological position resulted in women being eliminated from several fields of study, mostly in technical and engineering (STEM subjects) such as "mining, petroleum engineering, veterinary science and agricultural engineering" (Mehran, 2003, p.12). Women were also restricted from entering certain professions, such as law, and were not allowed into HE programmes such as agricultural engineering and veterinary sciences (Rezaei-Rashti, 2012). Furthermore, in order to implement Islamisation, many changes occurred in the education system. Mehran (2009) briefly explains some of these reforms:

> *Compulsory veiling, banning co-education at the pre-university level, reinforcing gendered practices by determining ''appropriate'' fields of study for women, compiling different technical-vocational textbooks for girls and boys, and barring unmarried women from studying abroad using state scholarships were some examples of post-revolutionary educational policies to ensure that women do what is deemed ''proper' (p.543).*

However, whilst it appears that the idea was to use education to create the ideal Muslim woman by encouraging them to take up their family responsibilities (as a good mother and wife), the eight year war with Iraq (1980-1988) gradually began to create the need for women to be more active in the labour market (Rezaei-Rashti, 2012). During this war, debates started around the tension between women's domestic responsibilities and their duties in the public domain, which had consequences in terms of the purpose of education. Therefore, this apparent contradiction (ibid) led Iran in to a transitional period.

#### 2.6.1.2 Transitional Period (1987-1997)

As highlighted above, during the war with Iraq, the economic role of women became important, which was not an unexpected issue. In a situation of increasing poverty and indebtedness and decreasing oil revenue, the government needed to implement a new social and economic plan (Rezaie-Rashti, 2012). In this respect, Koolaee (2014, p.280) (a researcher at Tehran university) mentions that, in this period, "women could be considered as one social group that confronted the diverse impact of war and were able to take up some roles that differed from traditional female roles".

Consequently, in 1987, the government established the Women's Social and Cultural Council (WSCC), where the role for working women was evaluated (Rezaie-Rashti, 2012) (see Appendix 1 for the summary of WSCC's aims).

During this period, it is generally accepted that women were encouraged to participate in the labour market whilst at the same time keep their traditional role in the family. This proposed the duality of women's role in society and can be defined as a transitional period. By transitional, then, I mean that, during this period, a woman's role was defined both as a good mother and wife as well as a profitable source of human capital. In other words, the meaning of being a good Muslim woman during this period is a woman who can play both roles perfectly inside and outside of the home. Based on this, ideas around the function of the education system changed and, in 1988, a new plan for the General System of Education in the Islamic Republic of Iran was published. Mehran (2003, p.275) provides a summary of the plan and argues there is a clear emphasis on women's empowerment both within the home and society (see Appendix 2 for the summary). The key aims of this Education Plan was to assign different roles and responsibilities for boys and girls, and to make clear distinctions early in their lives while trying to empower young girls and women in the field of education, society and home.

Therefore, the first economic, social, and cultural development plan was published in 1989 which, according to Mehran (2003), had two aims:

> *a) Improving the conditions of women through education and increasing women's participation in the socioeconomic affairs of society and family, and (b) bringing about a higher level of participation among women in social, cultural, educational, and economic affairs while maintaining the values of the family and the character of the Muslim women (Mehran, 2003, p.275).*

As a result, in response to these policies, WSCC removed all restrictions on women entering any fields of study in 1993 (Rezai-Rashti, 2012, p.5). Women were encouraged to study engineering and their role as human capital became much more visible in policy. Removing barriers and allowing women to enter any subject of study, at this point, may explain the increase in women choosing male dominated

subjects (e.g. engineering) at university, as outlined in Figure 2. Therefore, after the war, an apparent change occurred in the positioning of women in Iranian society, driven by the apparent need for human capital. The espoused discourse on such change indicates that the war led the government to alter their traditional perceptions towards working women, and this directed Iran towards a modernisation period. In relation to this, it is also argued by those in sections of feminist civil society that the empowering of women as a consequence of the Iran-Iraq war had unintended consequences since it produced an increase in educated Muslim women which contributed to the development of "a feminist movement based on the evolution of female consciousness" Ansary (2013, p.1).

#### 2.6.1.3 Modernisation Period (1997-2005)

It is generally perceived that modernisation or liberalisation was substantially strengthened in Iran by President Khatami who was elected in 1997, mainly due to a widespread desire for change (Menashiri, 2001). "Women's votes were crucial to the election of president Khatami and to the formation of a majority reformist parliament in 2000" (Moghadam, 2004, p.4). According to Menashiri (2001), Khatami was not an 'average mullah' but a president 'with one foot in western civilization' and, as such, he was not the "best representative of the ruling religious institution" (Menashiri, 2001, p.202). Khatami is thought to have rejected the idea of male superiority, stating that "women and men are different, but the woman is not the second sex and the man is not superior" (Today's Woman, 1997, cited by Mehran, 1999).

During the Khatami era, women's participation in university increased rapidly, reaching its highest level ever in 2002-2003 (this also corresponds with the statistics I presented earlier in Figure 1) (Rezai-Rashti, 2013). It is noted by some that Khatami was aware of this increase but he also believed that it would gradually slowdown in time (Povey et al., 2012). Moreover, it appears that Khatami was also aware of calls for restrictions on female enrolment since he stated that:

> *In the early years of Revolution we made many restrictions for our female students to enter universities which led to a sharp decline in*

> *their progress. Then restrictions were gradually removed. As a result we witnessed the growth in women's participation in HE at a remarkable rate. In 2000, 60% of the students who entered universities were female. This may neither be ideal nor normal. But I believe that in the near future it will reach its balance. We have to let this equilibrium be restored naturally. It is not justifiable to artificially create obstacles for women and to reduce their participation in higher education. Current circumstances demonstrate that young women face more restrictions and deprivations than young men. The best way is to open the HE system at various levels to women and to remove the quota system in courses such mining, engineering and the medical discipline. (Khatami, 2007: 246, published by Povey et al., 2012, p.43).*

The quote above also indicates a move from a human capital argument regarding female participation in HE towards an equality argument. In this respect, Khatami attempted to demonstrate his commitment to gender equality by electing Mrs Massoumeh Ebtekar as Vice President (the first female Vice President in Iran) and she also became the Head of the Organisation for the Protection of the Environment. Moreover, Zahra Shojaie was appointed as the advisor to the president for women's affairs (Rezaei-Rashti, 2012). During this era, the state's beliefs in the rights of female students to study and to work in managerial areas and in the science and engineering sectors were also reflected in the National Report about Women's Status in the Islamic Republic of Iran published in 2001 (see Appendix 3). The key aims of the report were to challenge traditional roles for women (or to create boundaries for women within the definition of good mother and wife), to raise confidence in women, and to encourage women to study male dominated subjects. There were some changes or initiatives in educational policy which reflect such beliefs, such as the plan to develop counselling services in high schools in order to prepare women for studying subjects which were typically 'male dominated' previously. There was also a push to utilise various forms of communication such as TV and newspapers, to transform traditional perceptions regarding women in the general public as a means to push gender equality further.

However, the political opposition (conservative) in Iran criticised Khatami's promotion of freedom for women (in several domains) (Menashiri, 2001). Therefore, it is widely accepted that the beliefs operating in policy during this liberalisation period were not favoured by the supreme leader Ali Khamenei, which

many think led to the appointment of Ahmadinejad as a conservative president, as a means of switching government policy back towards traditional values. The rebirth of traditionalism can be classified as the resurgence of conservative ideas towards women (Rezaei-Rashti, 2012), which I explain more clearly in the following section.

#### 2.6.1.4 The Resurgence of Traditionalism (2005-2015)

This period is typically thought to emerge with the election of Ahmadinejad as a conservative president in 2005. At this point, the signs of a traditionalist backlash began to appear in Iran more prominently (Rezaei-Rashti, 2012). Ahmadinejad was re-elected over Mosavi, a liberalist candidate, in what is widely believed to be very dubious circumstances in 2009 (Open Democracy, 2012). In this respect, Open Democracy states that women were at the forefront of voicing criticism of such events:

> *When Ahmadinejad was declared the overwhelming winner in very dubious circumstances, many activists reacted in anger and women were at the forefront of the ensuing protests, along with their male counterparts they suffered arrest, incarceration, and exile (Open Democracy, 2012, online).*

The espoused discourse regarding this resurgence period is that the government attempted to stop any moves towards modernisation. One such strategy was to create a 'Special Council for Development and Promotion of Humanities' (Rezai-Rashti, 2012, p.8). The Council hired seven humanities specialists who were responsible for monitoring subject disciplines (both in universities and schools) in order to ensure that the Islamisation of the disciplines was taking place (ibid).

The most important policy document in relation to my research, which was implemented during this time, was the 2012 HE guideline mentioned in Chapter 1, which restricted women from 77 academic fields in 36 public universities across the country. These courses included technical and applied science majors, political science, computer science and engineering (ibid). According to Rezaei-Rashti (2012), these fields are considered more prestigious subjects in Iran, and attaining a degree in them is advantageous in terms of finding a job after graduation and earning

a higher income. Thus, such restrictions were likely to have a significant impact on the status of women in relation to HE and their ability to access forms of education which might lead to social mobility of some sort.

In 2013, Rouhani became the president of Iran and, at this point, the 2012 HE guidelines were still in place. My interviews with the participants who took part in this research took place in 2014-2015 and, therefore, this policy significantly informed my rationale for this study.

#### 2.6.1.5 Summary of Section

My reason for presenting this account of educational policy in Iran over these recent decades is to highlight a conflicted and ever-changing set of ideological beliefs at work regarding women's access to HE. This has led to several critical commentaries, for instance, Mehran (2003) argued that, despite three decades of effecting changes to female participation in the education system, the government failed to achieve its main goal which was to create the 'Ideal Muslim Woman'. Paivandi (2008, p.2) notes the unique nature of the Iranian system when s/he states that it is unusual when compared to other educational models: "we cannot describe this system within the usual framework of modern or traditional; it is an unusual educational system that has passed through a process of de-modernisation". For this reason, I argue that the Iranian education system provides a unique context for researching gender, since it has undergone varied and conflicting ideological shifts over the past three decades.

Furthermore, another consequence of this shifting picture - from modernisation to de-modernisation, and the subsequent shifts in ideologies regarding gender, is the impact on the social and cultural expectations, beliefs and aspirations of Iranian society. One might expect conflicting positions on gender in Iran to not only play out in policy but also in practice - between parents and their children and/or between men and women. In the next section, I discuss this further.

## 2.7 Contradictions in the Iranian Socio-Cultural Context

As can be seen above, the fluctuation of various government policy documents regarding female education and women's access to university study (e.g. from de-modernization to modernization) is thought to be relevant to the observed evidence that women in Iran are choosing to study STEM subjects at university. However, the increasing number of female graduates I have highlighted above is in contradiction with the labour market data, which highlights decreasing women's employment opportunities. For instance, Table 3 shows the rising unemployment rate among female university graduates, which increased from 36% in 2006 to 49% in 2011. This is a contradiction which makes this context a particularly interesting place to look at female participation in STEM subjects. In other words, as education levels of women are rising, the number of women in employment is decreasing. The impact of this is an increasingly educated female population but with decreasing employment trajectories.

Furthermore, whilst there have been fluctuating ideological shifts in policy on women's participation in Iranian education (including Higher Education), in recent years, many families remain highly aspirational for their daughters to study at university. According to Rezaei (2012), on the one hand, Iranian women are encouraged by family and school to achieve the highest level of education possible. But, on the other hand, the 'traditional' and 'Islamic' government, traditional school textbooks and a male dominant labour market make it difficult to view women as a source of economic capital (Rezaei, 2012).

Moreover, there is also conflict between policy and practice (work force) in the Iranian context, where female graduates are encouraged by policy-makers to enter the workforce but then face barriers to accessing employment, and face discrimination when there. Writing in 2003 before the period of de modernisation outlined above, Mehran (2003, p.277) argued that the written policies of the past three decades never aimed to isolate women from public life, "however the situation was often different in practice". According to Ball (1994, p.11), "Policies are crude and simple. Practice is sophisticated, contingent, complex and unstable". Thus,

policies when implemented in practice are often interpreted and changed by those who are its object.

Thus, there are constraints that women are faced with in Iran 'in practice' as well as through policy, through the dominance of the labour market by men. This is mentioned by many scholars such as: Moghadam (2003), Rezaei (2012), Shavarani (2006), Rezaei-Rashti (2011, 2013), Povey (2010) and Povey et al. (2012). These literatures also show middle class aspirations regarding female employment with many women aspiring towards high paid careers. They also detail the barriers such women face on their way to success. For example, Rezaei-Rashti (2011) reported on focus group interviews with four Iranian female graduates in order to learn about the difficulties they face in the labour market. The paragraph below shows some of the barriers experienced by these women, which I argue is further mediated by the government's move towards conservatism regarding gender.

> *One of the most important aspects that the four participants talked about was the importance of having personal connections to access the labor market. They also discussed the difficulties of gaining managerial and administrative positions because of various reasons, such as being a single woman, not wearing what conservative males deem to be the proper Islamic hijab, the persistence of conservative attitudes toward women and also corruption in some government workplaces, as was the case with the building inspector (Rezaei-Rashti, 2011, p.93).*

As an example, one of the participants from this study, who is a civil engineer in a municipality building inspectorate, argued that:

> *It is not easy for women to obtain jobs in technical fields because the prevailing attitude is that men are more capable of performing those jobs (Rezaei-Rashti, 2011, p.90)*

She also noted "a specific bias against women in her position of building inspector":

> *I know that they would rather have a man in this position. Because they know how to bribe a man and they have experience with that. But they don't know how to bribe a woman. There is no prior experience with that. (Rezaei-Rashti, 2011, p.91)*

As a result of this body of evidence and the labour market data which highlights areas of low participation for women, I argue that many women are facing gender discrimination in accessing the workplace which is compounded by a male dominant labour market. This situation conflicts with the increased number of female graduates and the need for increased productive labour power to develop the Iranian economy. Arguably, it is this conflict which underpinned the 2012 HE guideline to restrict women's access to some university courses such as technical engineering (thereby reducing the number of female graduates). However, the conservatism which underpinned this policy is at odds with the aspirations of many families who wish their daughters to study highly valued subjects such as engineering at university. Regarding this claim, Professor Majid Abbaspour, a lecturer in the school on mechanical engineering at Sharif University, said to the BBC:

> *Mechanical engineering and courses such as technical engineering had only four women. Now the number has changed a lot – I think this may be because the attitudes of families have changed (BBC, 2006).*

As such, there is a perceived sense that, in some sections of Iranian society at least, there has been a substantial shift in attitudes towards women in relation to HE and that this has resulted in increased numbers of women studying subjects like engineering, in spite of restrictions imposed by the HE guidelines.

In the next chapter, I discuss the evidence regarding such female enrolment on STEM programmes at university in Iran and discuss how this contrasts with other countries around the world.

## 2.8 Conclusion

In general, the evidence I have discussed in this chapter indicates that there are two factors which make the Iranian HE context particularly interesting in terms of studying gender and participation on STEM programmes: 1) increasing levels of female participation in STEM programmes which corresponded with decreasing level of female participation in labour market; and 2) fluctuations in government policy regarding female education and women’s access to university. As a result, I

argue that Iran provides an interesting context to study female participation in STEM because such fluctuations are underpinned by shifting and contrasting ideological beliefs about gender. In the next chapter, I move on to discuss the research evidence which seeks to explain the relationship between gender and access to STEM in Higher Education, in order to establish: i) the concepts which are useful in understanding this relationship; and ii) what a study situated in this Iranian context might add to our current understandings of gender and STEM participation (a research rationale).

# Chapter 3 : Literature Review

## 3.1 Introduction

In this chapter, first I look at the position of women in STEM to better understand the issues relating to women's participation in STEM globally. In this section, I discuss the statistical patterns which highlight the shortage of women in both HE and in the STEM labour market, particularly in mathematics and engineering. Secondly, in order to consider explanations for this shortage, I have divided the literature into two different parts: female participation and access to STEM subjects at university; and careers and gendered aspirations in relation to STEM. Moreover, I look at other factors such as race, religion and social background which are influential in order to build an argument around women's choice of STEM. As already suggested in Chapter 2, I argue that studying these issues requires an understanding of gender which recognises its complexity and intersectionality with other categories like ethnicity, religion and social background. Thus, I argue that the literature has moved from looking at gender as a discrete (even biological) category, towards seeing it as a culturally constructed concept which does not have clear boundaries. Finally, this literature review concludes with a statement regarding the gap in current literature in order to show the importance of this study.

Overall, this chapter aims to situate the patterns regarding Iranian female participation and aspirations to study STEM subjects (discussed in the previous chapter) in relation to global patterns, and thus further highlight the distinct and culturally complex nature of the Iranian context for women studying or aspiring to study mathematics and engineering. As can be seen from Chapter 2, the Iranian context contains several contradictions and conflicts which may influence the relationship between gender and participation in mathematics and engineering in Iran. Therefore, this chapter will not only look at how this context relates to findings elsewhere, but will also consider how far explanations regarding the relationship between gender and participation, which are established in the research literature, can be applied to the Iranian context.

## 3.2 Gender and Women's Positioning in STEM

Gender is often considered an important factor in research on participation in STEM at university because, in many countries around the world, there is a shortage of sufficiently qualified people going to STEM.Therefore, increasing female participation is seen as central to addressing this problem and thus meeting the STEM agenda (Blinckenstaff, 2005). For example, in the United States, the NSF (National Science Foundation, 2018) reported that insufficient numbers of graduates are going into the engineering labour market (such as civil, mechanical, computer and chemical engineering), with women seen as an under-utilised resource and a solution to address this shortage (NSF, 2018). In the UK, historically, the government has repeatedly attempted to attract young people to study STEM in order to improve economic performance towards widening participation in science and engineering (Epstein et al., 2010). This has been the focus of much research also, for instance, the TransMathematics  projects at the University of Manchester aimed to "understand how cultures of learning and teaching can support learners in ways that help widen and extend participation in mathematically-demanding courses in F&HE" (Williams et al., 2008, p.1).

In this sense, like in Iran, women are often seen as embodying human capital to increase economic productivity in STEM sectors, an argument which is now widely critiqued as problematic for a number of reasons. Firstly, it assumes a symbiotic relationship between knowledge acquired in education and that used in the workplace, where one is directly implemented in the other. Secondly, it assumes individual needs can only be understood in relation to the needs of the 'whole' (in this case, the economy). This ignores the complexity of individuals' motives (personal, social or otherwise) to study and then take up STEM careers (Black et al., 2010). Thirdly, it vastly over-simplifies the complex positions individuals (including women) take up in societywhich are above and beyond the value of their labour power. Thus, evidence suggests that, even when women are suitably qualified in STEM subjects, they are far less likely than men to engage with professional fields and mainly choose to become teachers (Flabbi et al., 2012). Among graduates with science degrees, 71% of men but only 43% of women work as professionals in physics, mathematics and engineering in OECD countries (ibid). In the UK (August

2015), the participation of women in STEM careers is reported to be only 14.4% of the total STEM workforce (WISE, 2016) and the National Statistics indicate that women make up around just 8% of engineers in the UK (BBC News, 2016). BBC News (2015) also emphasises that, compared with European countries where the percentage of female engineers is around 20%, the UK has a particularly low percentage of female engineers (in the US, this figure is around 14%).

In many western countries, the shortage of women in the STEM labour force is further exacerbated by low patterns of participation in STEM subjects in universities (WISE, 2016). In the UK, the participation of women on mathematics undergraduate and postgraduate degrees is 41% and 27%, correspondingly (ibid). In engineering, in 2012-2013, 27,000 applicants were accepted into engineering but only 13% were women (with 12% in computer science and 18% in engineering) (Engineering UK, 2015). In 2016, the participation of women in STEM (this includes medical sciences and biology) was 25% of the total and this situation has been fairly static since 2014 (WISE, 2016). Therefore, in the last three years, there appears to be no significant growth in the participation of women in STEM subjects in the UK.

In the USA, women are also underrepresented in STEM at all levels of study and the participation of women in relation to men in science, mathematics and engineering degrees at the graduate level are: 35% of bachelor's degree, 26% of master's degrees, and 24% of doctoral degrees (Sax, 2001, p. 153). More recent data has failed to show much improvement and, in 2015, the number of women in engineering, mathematics and physical science bachelor degrees was at 20%, 43% and 39% respectively (OECD education at glance, 2015).

In OECD countries, the share of women graduates in the field of engineering is also considerably lower than men, with an average of 24% women compare to 76% men (OECD education at glance, 2015). In the field of mathematics and statistics, the average share of women graduates is slightly better at about 45% compared to 55% of men (ibid). Furthermore, in OECD countries, less than 1 in 3 engineering graduates are female, decreasing to less than 1 in 5 in computer science programmes (ibid.).

Therefore, despite increased resources and attention addressing a perceived need to increase female graduates and employment in STEM subjects and careers, there has been little improvement of female participation in STEM at university in many western countries like the UK and USA (n.b. this contrasts with the Iranian context where the participation of women in STEM in HE has increased historically and where women take up a larger share of the student population in STEM subjects, as shown in Chapter 2). In the sections that follow, I now discuss the potential explanations for the recognised gender gap in mathematics and engineering degrees and STEM more generally. The aim is to consider whether such explanations are useful to my research in terms of unpacking women's experiences of participation in mathematics and engineering in Iran and if not, why? The point is to provide a backdrop with which to situate the account that will be put forward in this thesis.

## 3.3 Gender and Achievement in Mathematics and STEM Subjects

One explanation that might be proposed is that female under-representation in HE engineering and mathematics programmes and careers can be accounted for by their prior achievement. However, the research on gender and school mathematics indicates the apparent paradox between girls' increasingly high academic achievement in mathematics and their low participation in mathematics and STEM subjects at post-compulsory level. For instance, in England, girls are seen to be outperforming boys in mathematics examinations at every level (DfE, 2015) but Sheldrake et al. (2015) report that "on average fewer girls than boys sat A-Level mathematics examinations, although girls and boys generally performed equally" (Sheldrake et al., 2015, p. 463). Furthermore, in England, Solomon (2012) points out that female students do not typically choose STEM subjects at university, even though they achieve high enough grades in STEM at the end of compulsory schooling. As such, Solomon refers to women being positioned as 'successful but not succeeding' (Solomon, 2012). Therefore, achieving high grades at the compulsory level does not appear to be a main factor in shaping female students' dispositions to study STEM subjects further and develop a career in STEM (Pampaka et al., 2011).

It is worth mentioning that this trend (girls attaining higher in mathematics) seems to also be the case in the Iranian context. A comparison of TIMSS 1999 and 2003 data in Iran indicated significant increases in female attainment in mathematics across this period, and the same data also shows a significant decline in the male students' attainment at Grade 8 (Kiamanesh, 2004)[6]. More recent TIMSS data (2015) also shows that girls achieved higher scores in mathematics than boys at Grade 4 in Iran, with an average difference of 10 points, however at Grade 8 there is no difference between girls and boys (TIMSS, 2015). However, a trend towards higher mathematics achievement in school by female students is not a global phenomenon, with countries such as Egypt and Chile showing lower attainment for girls when compared with their male counterparts in TIMSS 2003 and 2007. According to TIMSS 2015, out of the 49 countries, in 18 countries boys had higher achievement, in 8 countries girls had higher achievement, and 23 countries had no differences between boys and girls.

Furthermore, according to TIMSS data the average mathematics achievement by gender is typically higher within single-sex schooling countries such as Saudi Arabia and Oman-girls score higher in single-sex schooling countries. However, the findings on this are unclear. Some studies provide evidence that single-sex schooling is beneficial for girls in terms of their mathematics achievement (Alsindi, 2013; Link, 2012; Seifert et al., 2009). On the basis of which, some educators in the USA have argued for the provision of single-sex classes in order to reduce the gender gap in STEM (Seifert et al., 2009). On the other hand, some studies suggest that there is no difference in mathematics achievement among girls in single-sex schools (Doris et al., 2013). For instance, Lee et al. (2014, p.474) show that, in general, "single-sex schooling does not reduce the gender gap in competitiveness". Furthermore, Hubbard et al. (2005, p.115) demonstrated that the apparent success of single-sex schooling in California was "due more to the interrelated contributions of the schools' organizational characteristics, positive student-teacher relationships, and ample resources" rather than in mathematics/STEM attainment.

[6] "The Trends in International Mathematics and Science Score (TIMSS) and Progress in International Reading Literacy Study (PIRLS) are the largest and most comprehensive international studies that Iran has ever participated in" (Kiamanesh, 2004, p.1).

Therefore, I argue that the relationship between academic attainment in mathematics and participation in STEM subjects at HE and beyond is complex. Whilst some countries display signs of a paradox (UK/USA), others report alignment between girls' low achievement and their low participation in post-compulsory education (e.g. Chile). In Iran, the recent TIMMS data indicates relatively similar attainment between male/female students (at grade 8) but the data on access to university suggests that female entrance on to STEM (and particularly engineering programmes) is higher than elsewhere. Thus, the paradox that exists in the UK/USA is not immediately apparent in Iran. Therefore, it is difficult to establish whether prior attainment can explain gendered participation patterns in HE STEM, suggesting we need to look at other explanations.

## 3.4 Explanations for Low Female Participation in STEM

In order to consider the research literature on female participation in STEM subjects more thoroughly, I will now discuss explanations including biological factors, psychlogical factors, cultural forms, expectations and stereotypes around mathematics and engineering. Explanations which relate to cultural forms see women's positioning in relation to STEM subjects as socially and culturally constructed rather than being about their biological sex. Through this study, I will explore why women have enrolled on mathematics-engineering courses in Iran in increasing numbers by exploring students' narratives about their choices, experiences and aspirations. Therefore, to understand this matter I am interested to know how women value the degree programmes they are undertaking and how such values connect to their choice of degree and their future aspirations which I explain more below.

### 3.4.1 Biological Determinism

Historically, scholars (Sadker and Saker, 1994; Hyde, 1996; Baron Cohen, 2003; Carr et al., 1997) have stated that biological differences between men and women explain the fewer numbers of women studying STEM at university (mainly in Western countries) and entering STEM professions. This perspective makes claims such as "the difference in size of men's and women's brains as the cause of female

‘intellectual inferiority’” (Sadker and Sadker, 1994; Hyde, 1996 cited by Blinckenstaff, 2005, p.372). This explanation suggests that men and women are simply biologically different and, therefore, have different abilities/competencies. As such, men are biologically structured to be better at reasoning, and therefore predisposed towards competence in mathematics (and mathematically demanding subjects in STEM), and, as a consequence, they are more inclined to opt to study these subjects at post-compulsory level.

The biological difference argument has more recently been proposed by Baron Cohen (2003) in his book 'The essential difference' which makes a causal link between biology and gender in terms of different learning styles or predispositions of men and women. Baron Cohen (2003) argues that male and female brains are different:

> *The female brain is predominantly hard-wired for empathy. The male brain is predominantly hard-wired for understanding and building systems (p.1).*

Here, ‘empathy’ means understanding the feeling of others and "it is done in order to understand another person, to predict their behavior, and to connect or resonate with them emotionally" (p.2). Systemising, on the other hand, means constructing a system to understand how things work and "it is done in order to understand and predict the system, or to invent a new one" (p.3). As a result, STEM subjects are viewed as systemising subjects which suit the male brain, and this explain women's low predisposition towards STEM subjects. Carr et al. (1997, p.318) make similar inferences in their discussion of 'strategy use' in mathematics, arguing that "girls were more likely to count on fingers or use counters (overt strategies); boys were more likely to use retrieval (from memory) to solve addition and subtraction problems”.

A similar but slightly different argument comes from Belenkey et al.’s (1986) book entitled ‘women's ways of knowing’ which suggest that women favour different kinds of knowledge to men and this explains the differences in participation in STEM-related subjects. This theorises that women do not typically acquire

knowledge through independent academic work since they prefer to learn through networking :

> *For many women, the 'real' and valued lessons learned did not necessarily grow out of their academic work but in relationships with friends and teachers, life crises, and community involvement (Belenkey et al. (1986, p.5)).*

Belenkey et al. (1986) argued that many women believe that men are more successful in the development of ideas and thoughts and therefore men are more disposed to study mathematics than women. Although they do not pin this theory to biological differences between men and women, they do essentially present gender as something fixed and culturally deterministic in the same way that biological explanations do (i.e. female = preference for connected knowing, and male = preference for understanding how things build up). This offers no sense of escape or alternative:

> *All women grow up having to deal with historically and culturally engrained definitions of femininity and womanhood- one common theme being that women, like children, should be seen and not heard (Belenkey et al. (1986, p.5)).*

However, in Mendick's (2010) study 'Mathematical stories: why do more boys than girls choose to study mathematics at AS-level in England?', Mendick (2010) rejects such determinism, and particularly the idea of biological determinism, and argues that lower participation of women in STEM (in the UK at least) is a socially-constructed phenomenon. Furthermore, both Solomon (2012) and Mendick (2010) argue that such deterministic arguments essentialise gender differences as residing inside the individual. From this perspective, the responsibility for inequalities in participation and/or achievement in STEM subjects is not located in the social practices which constitute mathematics/STEM, but in the individual. Ultimately, women's neurological make-up (and as such women themselves) are positioned as responsible for differences in STEM participation rather than some form of discrimination or inequality in practice. This critique concurs with my own approach to gender and participation in STEM in this research where gender is seen as socially and culturally constructed in specific ways (rather than biologically stratified). I also

argue that these social constructions of gender are held in relation to policies that also mark gender in particular ways (shown in Chapter 2).

Moreover, there are other problems with an argument for biological determinism. As noted above, there are differences between countries regarding achievement and participation, with some countries reporting girls as higher-achieving than boys in mathematics. Stephen et al. (2009) also report variations in female participation in STEM with some increases observed. Thus, it becomes impossible to argue that essential biological characteristics common to all female students may be responsible for differences in attainment and participation, when such differences vary culturally. This evidence suggests the need to recognise gender as a more complex cultural phenomenon in order to account for differences between countries, but also other social groupings (see below on intersectionality).

### 3.4.2 Psychological Explanations/Self-efficacy

Another lens used to explore the relationship between gender and STEM participation/attainment focuses on self-efficacy in mathematics (i.e. low levels of confidence regarding one's expectations of competence in performing mathematical tasks). In western contexts, this argument has been put forward by authors such as Macphee et al. (2013), Pampaka et al. (2011), Hutchison et al. (2006) and Pajares et al. (1997). As an example, Pampaka et al. (2011) found that there is a relationship between mathematics self-efficacy and gender, with those students reporting lower mathematics self-efficacy being mostly female. Macphee et al. (2013, p.347) conducted research with female undergraduates in STEM subjects at admission and at graduation data points. Their mentoring programs show that, in STEM subjects at admission level:

> *Women perceived themselves as academically weaker than men despite similar academic performance. However, by graduation, women's academic self-efficacy was equivalent to men's (p.347).*

This builds on earlier work by Pajares et al. (1995) who have shown that there is a strong relationship between self-efficacy and mathematics performance based on a survey with 329 high school students. They conclude that self-efficacy judgments

should be considered as a main factor in discussions of mathematical performance and participation

> *Students who have low levels of mathematics self-efficacy are at a high risk of underperforming in mathematics, despite their abilities (Bandura, 1997; Schunk and Pajares, 2009 cited by OECD, 2013, p. 4).*

This finding (that higher mathematics achievement relates to high self-efficacy) can also be seen in the top scoring nations in mathematics such as Singapore, Republic of Korea, and Chinese Taipei in TIMSS (O'Conner-Petruso et al., 2004). In the case of engineering, Hutchison et al. (2006) conducted a survey with 1387 first year engineering students and found that, again, self-efficacy was a significant factor predicting students' interest, persistence and achievement in the subject. They also found that female students possessed lower self-efficacy when compared with their male counterparts (Hutchison et al., 2006). Moreover, a Norwegian study investigated the relationship between self-efficacy and attitudes towards computing in both men and women (Busch, 1995). This study identified lower self-efficacy in relation to apparently complicated computer tasks (in both word processing and spreadsheet) among female students studying computer science. However, no gender differences were reported in levels of self-efficacy related to doing simpler computer tasks. Therefore, given this evidence, we can see that this construct is frequently used as an explanation for female low participation in post-compulsory STEM subjects in many western countries.

However, there are two studies in Iran regarding self-efficacy in relation to participation in STEM subjects at university which have produced findings that are slightly different (Shashaani et al., 2001; Rezaei, 2012). The first is a survey with 375 (155 males and 220 females) Iranian computer science undergraduate students which found that:

> *Women showed stronger beliefs in equal gender ability and competence in use of computers, but expressed low confidence in their own ability to work with computers. There were no significant gender differences in respondents' liking for computers or their perceptions of the usefulness of computers.Male and female*

> *students believed equally in the positive effects of computers on individuals and society (Shashaani et al., 2001, p.363).*

Shashaani (1997) also carried out similar research in the USA and found that there are significant differences in female students' interests towards computer science when compared with Iran, with less interest in USA. In her 2001 survey in Iran, she makes two points regarding female students' persistence in doing engineering courses:

> *Females strongly disagreed with the statement "men make better computer scientists and engineers than women", and agreed with the statement "females have as much ability as males when learning to use a computer".Male students were uncertain about both statements (Shashaani et al., 2001, p. 368).*

Thus, we can see that, in this study at least, there is a high degree of confidence regarding ability and computer science than might be expected given the other studies regarding low self-efficacy and STEM participation. A similar finding is reported in a more recent study by Rezaei (2012) who focused on science, engineering and humanities students. Rezaei (2012, p.393) explicitly hypothesised that increasing female enrolment in university "might be attributed to their gender based self-confidence and their self-efficacy". He conducted research in two different major cities in Iran (Ahvaz and Shiraz). The results from the quantitative data show that "female students scored higher on collective, gender-based self-confidence" (Rezaei, 2012, p.393). Thus, female students do not think they are less than male students, mentally, academically, or socially (Rezaei, 2012). Rezaei (2012) states that, whereas in other countries female students score significantly lower than male students on self-efficacy and self-confidence scales, this is not the case in Iran, with self confidence amongst female students being particularly high. However, female mathematics high school students appear to show lower self-efficacy in relation to mathematics indicating that the findings of Rezaei (2012) and Shashaani (2001) might be specific to students at university. Aghajani et al.'s (2012) study, based on a survey of 480 male and female students, focused on the relationship of self-esteem and self-efficacy to mathematical anxiety in high school students in Iran. Here, the findings showed higher mathematics anxiety among female students when compared with male students. Similar findings appear in

Sharifi Saki et al. (2014)'s study, as their survey shows lower self-efficacy among third grade high school female students when compared with their male counterparts

As can be seen here, the above literature focuses on psychological constructs (mainly self-efficacy) as a means to explain the influence of gender on students' attitudes towards STEM subjects and how such attitudes mediate the way they relate to these subjects. I have outlined a number of different disciplines which come under the STEM umbrella including mathematics, computing, science and engineering. It is also worth noting that these studies have tended to focus on gender as a discrete category without looking at gender in relation to other culturally constructed categories such as religion, class, etc. In the next section, I present research which draws on the discursive approach to explain inequalities in access and participation by arguing that STEM discourses are predominantly masculine and thus offer no space for women to choose STEM. This approach leads us to consider the intersectionality of gender with other social categories, which I will also consider below. My purpose here is to present such discursive accounts as another explanation present in the research literature to account for the low participation of women in STEM in western countries.

### 3.4.3 Discursive Explanations

Discursive explanations of low female participation rates in some STEM subjects centres on 'choice' and women's decision-making as a means to understand why many women do not opt to study STEM subjects in post-compulsory education, despite high levels of achievement. Here, the focus has been on discursive productions of gender and 'gender stereotypes' which are widely reported in western contexts (Mendick, 2005, Sax, 2001; Moreau et al., 2010; Epstien et al., 2010; Solomon, 2012). For instance, Solomon (2007) highlighted how many women perceive themselves as 'not belonging' in the world of mathematics, even when they are successful :

> *Not belonging is a prevalent theme in their accounts of the experience of studying mathematics , even though their choice of degree-level study indicates a belief that they are at least at some level 'good' at mathematics (Solomon, 2007, p.79).*

Mendick (2006, p.235) argues that "doing mathematics is doing masculinity". Thus, "choosing mathematics and being good at it compromises femininity, requiring identity work" (Solomon, 2012, p.171). So there is an issue of identity here "that popular discourses overwhelmingly construct mathematicians as white, heterosexual, middle-class men" (Moreau et al., 2010, p.25). In other words, mathematicians are seen as mad, male and virtually white (Epstien et al., 2010). Therefore, according to these discursive models (mad, male and white) women do not see themselves belonging to the world of mathematics (Solomon, 2012).

In addition, Mendick (2006) concludes that the discursive mathematical notion of 'nerd' and 'genius' can be seen as a barrier to choosing mathematics for both men and women. Based on this idea, Moreau et al. (2010, p. 25) argues that:

> *Whether students decide to carry on with the study of mathematics is related to gender, with boys more likely to continue with the subject, although the study of mathematics is losing popularity both with boys and girls (Mendick, 2006, cited by Moreau et al., 2010).*

This is also the case for engineering fields and, in general, the evidence suggests that women in the US and UK view engineering as a masculine field in which they do not belong (Blinckenstaff, 2005; Kuzmak, 2010; Sonnert, 1995a). Moreover, Archer et al. (2013) make a similar argument about science programmes as they believe that to be successful in science requires some degree of science capital which is mediated by gender, race and class (see the section below for more detail). Existing world-wide literatures in this area have also emphasised the notion that both mathematics and engineering are discursively constructed as masculine subjects (Rokis, 2011).

In Iran, findings from quantitative survey research have indicated that the masculine image of STEM subjects is shared by some students. Nejat et al.'s (2011) study (mathematics-engineering and humanities) of male and female students taking a whole range of subjects (including mathematics but also humanities) found that, whilst most students perceive mathematics and engineering to be masculine fields, fewer female students of mathematics-engineering programmes think mathematics

is a masculine subject when compared with both male students in the same major as them, and their same-sex counterparts studying in humanities majors. In sum, female students in mathematics-engineering are less likely to endorse strong mathematics-male beliefs (ibid.) when compared with male students and those in other disciplines. However, Nejat argues that this study provides only a snapshot of the ongoing story (Personal Communication, 2013). Methodologically speaking, this study is cross-sectional rather than longitudinal (ibid.) and, therefore, it does not assess the strength of stereotype endorsement both before and after the particular point in time in which the survey was conducted (2011) (ibid.). Therefore, Nejat claims that it is perfectly conceivable that people's (including women's) stereotypes of academic disciplines such as mathematics or other STEM subjects are malleable and thus constantly changing as a consequence of changes in the real world (Personal Communication, 2013). In other words, as the presence of women in Iranian universities increases (particularly in mathematics and engineering), both male and female students may tend towards editing their beliefs, thereby considering mathematics-engineering to be less masculine (ibid.). Henceforth, this gives rise to a feedback loop with women registered in mathematics-engineering fields challenging stereotypical beliefs, which in turn encourages more women to enter mathematics-engineering fields (ibid.).

This argument holds similarities with Solomon's (2012) notion of re-figuring the mathematics world of masculinity; this UK study focuses on how some female undergraduate students are finding new spaces for inclusion in the world of mathematics. Based on this idea, Solomon (2012) argues that:

> *Some women resist traditional positioning in the mathematics world, drawing on local resources which enable a sense of agency as successful students and a refiguring of their relationships with mathematics (p.565).*

As a result, we can conclude that discursive gender stereotypes which relate to mathematics/STEM are apparent in Iran and in the UK, but the extent to which they inform student decision-making is complex and requires further investigation.

Other international studies also indicate relevant findings regarding gendered stereotypes in relation to STEM disciplines. For instance, a quantitative study of the

association between gender, computers and other major school subjects among Japanese and Swedish students found that, in Japan, computers "were judged by both genders (men and women) as being more useful to boys than to girls" (Makarakis et al., 1996, p.228), but this was not the case in Sweden. Moreover, in both countries "girls consistently reported that computers, mathematics and sciences were the subjects which were less liked and languages the most liked" (1996, p.225). Another example relates to engineering in Malaysia. Rokis (2011) reports on a qualitative case study of female engineers in a context where engineering courses and occupations are seen as male-dominant. This study noted a conflict between traditional discourses regarding gender (being a Muslim woman) and those of modernity (being an engineer) which was spoken of by Malaysian women engineers. Based on this evidence, Rokis (2011, p.403) stressed that "the gendering issues in engineering overwhelmingly projected the collision between modernism and traditionalism" with 'modern' women (Malaysian women engineers) still preferring to keep their feminine-traditional roles and resulting in a clash of traditionalism and modernism (Rokis, 2011).

The finding regarding discursive explanations indicate that the discursive construction of a STEM male stereotype is globally recognised but takes on specific form in different cultural contexts and also across different STEM disciplines. Thus, I suggest that the relationship between gender and how STEM subjects are discoursed is complex and situated in specific socio-historical conditions. However, the category of gender (or being male/female) is also culturally constructed and also intersects with other social categories of race, social class, etc. Below I argue for the need to recognise intersectionality in locating explanations of who accesses STEM subjects and why.

### 3.4.4 Intersectionality Explanations

In this section, I discuss intersectionality in order to show that issues regarding low participation in STEM do not only focus on gender as an isolated category, but rather see gender as part of a more complex picture. Here, I argue that, in order to fully understand women's participation and identification with STEM, there is a need to move towards a more complex idea of what gender is, and to recognise gender as

framed in relation to particular social backgrounds and religions. Thus, I move towards considering the intersectionality of gender with other factors like class, religion and ethnicity. As I argued earlier, in this thesis I see gender as not about fixed biological differences between men and women but as a culturally constructed phenomena which does not have clear boundaries around it, hence the fluidity of the concept and the relevance of other markers of identity such as religion, social class position, etc. to understand aspirations and choices in relation to STEM. In this respect, Iran provides a particularly interesting context to look at this complex intersectionality since the issues of class, religion and gender are intertwined both culturally and politically because of all the reasons I outlined in Chapter 2.

This position on gender and its intersectionality with other aspects of one's identity such as religion and/or cultural identity is present in some of the literature on participation in STEM. For instance, Black et al. (2010) provided a narrative study of a Muslim female student (Pakistani) in the UK who wanted to study engineering, resulting in a conflict between two different identities: her identity as a Muslim woman and her identity as an engineer (Black et al., 2010). The student narrates that she cannot be an engineer and be a good Muslim woman at the same time, thus there is a contradiction mediated by gender, religion and ethnicity which must be resolved one way or another. Archer et al. (2013) also discuss the intersectionality of gender with social class and ethnicity when they explore the influence of gender stereotypes on aspirations to study STEM:

> *In western developed nations, participation in post-16 science varies considerably by gender, ethnic background and social class, with those most likely to pursue degrees in the physical sciences being White (and Indian and Chinese heritage) men from middle-class backgrounds—a pattern which has persisted over many years(e.g., AAUW, 2010; Smith, 2010a, b, 2011, cited by Archer, 2013, p.1)*

Archer et al. (2013) discuss the stereotype of "brainy" as being associated with 'middle-class masculinity' and, therefore, they claim the intersection of gender and social class mediates access to the kinds of science capital one requires to construct a ‘brainy’ academic identity. They argue that this "results in science aspirations and participation being experienced as a 'natural fit' for many middle-class, academic

boys but as unthinkable for many working class boys" (p.6). Thus, Archer et al. (2013) argue that intersectionality is essential to studying "how and why social axes, such as gender, social class, and ethnicity, influence students' attitude to science and their post-16 choices" (p.1). In the US, the issue of intersectionality is described by Brickhouse et al. (2000) who conducted ethnographic research amongst African American girls from middle class and poor backgrounds who were studying science at grade 7. Brickhouse et al. (2000) portray intersectionality as the inter-play of ethnicity, class and gender and highlight that, by focusing on such intersections, the researcher is able to recognise more students being successful in science rather than alienated, and thereby challenge deterministic expectations regarding gender and participation in science.

However, the fact that ethnicity, gender and class mediate different patterns of participation in the US when compared with the UK indicates the complexity of the relationships between these socio-cultural categories. For example, in the US, Asian students have lower levels of participation and attainment in STEM than other ethnic groups (Shaw et al., 2010), whereas, in the UK, being Asian is seen as a benefit in participating in STEM subjects. Indeed, Archer et al's (2013) survey "show that a student is most likely to express science aspirations if he is male, Asian, has high levels of cultural capital, and has a family member who works in science or a STEM-related job"(p. 3). Thus, I argue that to explore the way gender intersects with social categories of religion, ethnicity, social class requires a deep understanding of the social-cultural context in which individuals are situated. In this study, I present such an analysis by exploring how the specific socio, historical and cultural conditions in Iran are manifest in female students' narratives about their choice and experience of studying engineering and mathematics. I am also interested in how the women in my study narrate their career aspirations and the extent to which such aspirations motivate them to choose STEM subjects at university. For this reason, I now discuss the research evidence on women and aspirations in relation to STEM careers.

## 3.5 Women's Aspirations towards STEM Subjects/Careers

In this section, I explore how the relationship between gender and students' participation in STEM subjects both in compulsory and post-compulsory education can be explained by focusing on students' aspirations. Here, the research evidence indicates that aspirations are crucial in shaping whether women choose to study STEM subjects at university. In this respect, Fabes et al. (2014, p.29) argue that "boys and girls have different career aspirations and career choices, although girls are more flexible in their choices". Based on this idea, they suggest such aspirations are communicated through normative gendered relations that begin in early childhood:

> *We argue that the gender-segregated nature of children's peer interactions that develops across childhood and adolescence sets the stage for many of the gender differences in attitudes, beliefs, motivations, and behaviors that contribute to gender differences in aspirations and choices (p.29).*

Here, I argue that, whilst the durability of discursive gendered relations are presented as set in place and deterministic of future career aspirations, this study does recognise a connection between aspirations and choices in order to explain lower participation in STEM subjects amongst female students. This is a dominant theme in the literature, whereby participation is linked to both decision-making and aspirations. Frome et al., (2006) conducted a longitudinal quantitative study (N=104) among women aged 18 to 25 who, at the outset of the study, aspired towards 'male-dominated careers'. In this respect, they tested two hypotheses that they believed might lower aspirations during the study's time period, or produce a change in career decision-making: 1) attitudes towards mathematics and science are lower amongst women; and 2) women desire for more flexible careers to combine career with family. They concluded that the "desire for a flexible job, high time demands of an occupation, and low intrinsic value of physical science were the best predictors of women changing their occupational aspirations out of male-dominated fields" (p.359).

The focus on the gendered nature of aspirations in relation to STEM subjects is a dominant finding in the literature. Several papers by Archer et al. (2012b; 2014) indicate lower aspirational attitudes towards science careers among girls when compared with boys in compulsory education. Consequently, Archer et al. (2014. p.2) argue that "examining masculinity can provide insight into inequalities in science attitudes, aspiration and post-16 participation".

However, conflicting evidence has been found in Canada. Shapka et al. (2006) reported a quantitative longitudinal study involving high school students (Grade 9-13) which indicated that men and women have similar aspirations (Shapka et al., 2006). The aim of this study was to find out to what extent "math acts as a 'critical filter' in shaping boys' and girls' aspirations to high status careers" (Shapka et al., 2006, p. 347). In doing so, they examined "the influence of early math achievement on career aspirations as they change over adolescence and young adulthood" (ibid). The findings indicated that many students, regardless of gender, believed that studying mathematics would lead them to higher status career.

Relatedly, a study of mathematics students' aspirations in the UK also revealed that the relationship between gender and aspirations in relation to STEM subjects/careers is not clear-cut. This study identified four distinct repertoires or themes in students' narratives about their imagined futures, some of which appeared gendered and others which did not. For instance, 'becoming successful' was one of the themes which was common across both male and female student's interviews (Hernandez et al., 2008). These students saw mathematics as a 'gate keeper' which would lead them to access a better career regardless of their gender. Similarly, the 'personal satisfaction' theme, which described the influence of 'personal interest and enjoyment' on student narratives about their aspirations, was also expressed by both male and female students. However, a theme identified as 'vocational' which related specifically to those who discussed using mathematics knowledge in an engineering career, was expressed mainly by male students on a vocational engineering course. Finally, the 'idealist' theme was narrated by those who discussed locating themselves in a better situation in the future through studying post-compulsory mathematics. This theme was narrated by more female students than male. Therefore, this study suggests that the nature of students' aspirations have diverse discursive narratives attached to

them, which must be critically reflected upon when considering the influence of gender.

This argument is also supported by Black et al. (2010) who conducted a narrative study of the relationship between students' mathematical identities and their career and HE aspirations in UK. In this study, the case of Mary (who dreams of becoming an engineer) contrasts with the findings of Hernandez-Martinez et al. (2008) above, since she narrates a 'vocational' identity similar to the 'vocational' theme which was found to be present in the interviews with male students.

To summarise, I conclude that there is conflicting evidence regarding the role of aspirations in explaining the lower participation of women in STEM subjects/careers. Whilst evidence of female students not aspiring towards STEM careers is presented by Archer at al. (2013), there is also some evidence to suggest many female students see STEM subjects (particularly mathematics) as a gatekeeper which will enable them to access a better life (Hernandez-Martinez et al., 2008). In fact, the evidence suggests aspirations are complex in that they are discursively constructed in relation to the circumstances in which the student is located and, therefore, I argue that this context must be recognised in unpacking how aspirations are influenced by gender.

## 3.6 Summary of Literature Review

The above literature review has highlighted a number of key factors which have been used to explain the relationship between gender and student participation in studying STEM subjects (both in compulsory and post-compulsory education). These explanations have focused on: biological factors; psychological constructs (e.g. self efficacy); discursive constructions or stereotypes of STEM and particularly mathematics as masculine (and therefore, alienating to many female students); and gendered aspirations regarding future study and careers. A key argument in my analysis of this literature has been to recognise the complexity of the relationship between gender and participation, which is mediated by decision-making but also the specific cultural, social and historical context in which students are located. I have

also argued that this requires some recognition of gender as a cultural construct: what it means to be a woman in a context such as Iran is likely to be quite different to many western contexts where the majority of the above research has taken place. Finally, I have also suggested that gender should be understood in terms of its intersections with other social categories of class and ethnicity, which is essential to recognising how social structures mediate individual perceptions of their own experience. I will now move on to describe the research gap which this study addresses, which will then be addressed in the remainder of the thesis.

## 3.7 Research Gap

The gap in the literature which this study addresses is the absence of research on female students' decision-making, experiences and aspirations towards studying STEM subjects in HE (particularly engineering) in Middle-Eastern countries. Although an abundance of research exists on the importance of such students accessing HE in general, currently there is very little which focuses on women studying STEM, particularly engineering.

To date, I have found only four papers which address this issue: Nejat et al. (2011), Shashaani (2001), Rezaie (2012), and Smith et al. (2010), all of which are discussed in this chapter and Chapter 2. There are also a small number of studies which have focused on students who study mathematics specifically such as Kiamanesh (2004), Saed Zadeh et al. (2014), Aghajani et al. (2012) and Sharifi Saki et al. (2014) in Iran. As already noted, these studies focus on quantitative survey data, except Smith et al. (2010) who used mixed methods to examine female students' roles in engineering programmes in Turkey. As such, these studies do not focus on the experience and the future aspirations of students studying mathematics and how this may be connected to culturally constructed concepts of gender and intersectionality, as suggested in some recent UK research (Solmon, 2012, Black et al., 2010). Therefore, there appears to be no qualitative research on female students who study mathematics or engineering in Middle Eastern countries such as Iran. This is important, as I argued in Chapter 2, as Iran is a particularly interesting context in which to look at gender and participation in engineering at university because of the contradictory ideologies in play.

## 3.8 Conclusion

By considering explanations regarding female low participation in STEM subjects at university which are espoused in the research literature, this chapter offers a critique which centres on the situated nature of students' decision-making and aspirations to study STEM, recognising gender as situated also. This argument suggests there are limitations in the extent to which explanations such as biological factors, self-efficacy and stereotypes are useful to this study, since they do not adequately account for the way social structures might be manifest in and mediate students' decision-making and perceptions of their own experiences. Therefore, this chapter has shown the need to further investigate female participation in relation to STEM subjects at university by recognising the distinct and culturally complex nature of the Iranian context which must be understood as social, cultural and historical. In the next chapter, I will discuss the theoretical framework used in this study to account for such cultural complexity, and to see connections been student narratives and the structures of wider Iranian society.

# Chapter 4: Theoretical Framework

## 4.1 Introduction

The theoretical framework that I will outline in this chapter has been developed to explore how the participants describe their choices, experiences and aspirations as mathematics or engineering students. In order to understand how the contextual conditions described in Chapter 2 are manifest in the participants' narratives, I demonstrate the need to use concepts derived from the work of Holland et al. (1998) such as identity, cultural models, figured worlds, and agency. I also discuss my use of Bourdieu's critical sociology as an analytical tool. Both Bourdieu and Holland et al. (1998) offer theories which can help understand the relations established within particular cultural contexts and also how ideological and structural conditions of power are manifest in localised practices. Therefore, in this chapter, I will show how the use of concepts such as identity, agency, positional identity and capital can be operationalised to help 'see' broader structures at work. A secondary aim of this chapter is to evaluate the use of these theoretical concepts and to explore their limitations.

## 4.2 Identity, Agency and Figured Worlds

Holland et al.'s (1998) book *Identity and Agency in Cultural Worlds* presents the concept of 'identity in practice', which serves as an umbrella for exploring other concepts such as Figured worlds, Positionality, Self-authoring and World- making. It presents a blending of the work of scholars such as Vygotsky, Bakhtin and Bourdieu. I have used it as part of the theoretical framework for this thesis because 'identity in practice' provides the means to explore how the participants construct a sense of self in relation to mathematics and engineering, which is mediated by the local socio-cultural-historical practices in which they are situated. Having said this, an important argument made by Holland et al. (1998) is that an individual's identity is not determined by their social circumstances and, as such, the notion of 'identity in practice' also allows me to see how participants exert agency over their

circumstances. To explore agency, Holland et al. (1998) draw on Vygotsky's theory regarding symbolic tools and cultural artefacts which are appropriated by an individual but then used to make meaning (and thus exert agency). It is the imaginary world of the symbolic meaning-making which gives some degree of freedom from structural relations. Below, I provide an account of the key concepts in Holland et al. (1998) in order to explain this theoretical argument further and operationalise it in the context of this research.

### 4.2.1 Identity in Practice

Holland et al. (1998) present their definition of identity (or identities) as follows:

> *People tell others who they are, but even more importantly, they tell themselves and then try to act as though they are who they say they are. These self-understandings, especially those with strong emotional resonance for the teller, are what we refer to to as identities (Holland et al., 1998, p.3).*

This suggests that narratives or rather our reflections on who we are and what we do are a significant component of an identity: we reflect on our experience 'in practice' and then extract from such experience to define ourselves as a particular kind of person. In a similar way, Gee (2001, p.99) sees identity as a "kind of person in a given context" and, since we encounter many contexts in our daily lives, we can say that we adopt or construct not just one identity (e.g. 'I am Nooshin') but multiple identities (e.g. 'I am a single woman, academic, engineer, etc.'). Thus, for Holland et al. (1998), identity emerges from the heart of culture. "Individuals live in worlds that are culturally defined and understand themselves in relation to these worlds" (Holland et al., 1998, p.54). The concept of identity from this point of view relates to how the individual understands themselves based on the particular cultural practices they participate in and then act accordingly – hence the term 'identities in practice' which combines both the internal individual psyche and the social world in which they participate:

> *...neither social life nor the world of the pysche… We reject a dichotomy between the sociological and the psychological. 'Person' and 'society' are alike as sites, as moments, of the production and reproduction of social practices... Identity is one*

> *way of naming the dense interconnections between the intimate and public venues of social practice... Identity is 'grounded in practice and activity...' (Holland et al., 1998, p.271).*

Following Black et al. (2010), in this research, I argue that the interview context through which I will collect my participants' narratives (see Chapter 5) provides a space for a special kind of 'identity in practice', where I have encouraged my participants to reflect on who they are and story themselves in a way that brings their multiple identities either together or into conflict with one another. Thus self-authoring/authorship in the research interview is a form of orchestration, whereby representations of oneself are brought together to address the interviewer, who occupies the standpoint of the 'other' in the activity.

> *...authorship is a matter of orchestration: of arranging the identifiable social discourses/ practices that are one's resources... in order to craft a response in a time and space defined by others' standpoints in activity (Holland et al., 1998, p.272).*

In sum, I argue that there is a coming together' of multiple identities, which is useful in exploring the complexity of my participants' lives. For instance, it can allow me to investigate how being an Iranian female relates to being an engineer or a mathematics student at university in Iran.

### 4.2.2 Figured Worlds

In order to explore how women talk about their identity in relation to mathematics and engineering, and also their future identities, I draw on Holland et al.'s (1998) concept of FW. Holland et al. (1998) describe how self-authoring an identity-in-practice is mediated and informed by an imaginary world of actors (figures), positions, events, beliefs (cultural models) and stories (i.e. FW which relate to that practice). A FW is a:

> *Socially and culturally constructed realm of interpretation in which particular characters and actors are recognized, significance is assigned to certain acts, and particular outcomes are valued over others (Holland et al., 1998, p.52).*

A FW, therefore, is the local context for identity work as ‘selves are socially constructed through mediation of powerful discourses and their artefacts’ (1998, p.26). Thus FW can be understood as the context for social activity, as a place of ‘being’ and ‘becoming’. Meaning that is attached to objects, acts, practices (artefacts) and roles is shared culturally and reconstituted by social performances that have specified value to those contexts and their historical discourses. FW are thus ‘the frames of meaning in which interpretations of human actions are negotiated' (1998, p.271).

Holland et al. (1998) argue their approach is broader than cultural studies, as the focus is on ‘the development of identities and agency in relation to practice’ (1998, p.7) rather than the construction and reconstruction of culture itself. Furthermore, they note that people assume and behave as if their actions, words and behaviour will be interpreted according to a context of meaning such as a FW. Such actions point to a specific position or location in a FW or rather index relevant ‘cultural models’ – the shared symbolic beliefs, ideas and meanings which populate a given FW (see below). In Holland et al. (1998), they describe the US college dating scene as an example of a FW where specific types of women take up more or less prestigious positions in accordance with cultural models regarding beauty (e.g. attractive women who confer capital on their male partners because of their physical appearance versus beautiful girls who are just beautiful enough to attract a high status male but not attractive enough to keep him). This exemplary FW is also populated by figures who individuals identify or dis-identify with and, in doing so, they mark out their position or status in the figured world. The FW of romance contains different figures for men and women. For example, the women refer to male figures as ‘cowboys’, ‘jerks’ and ‘pricks’, each of which have a mini cultural narrative attached to them (e.g. the figure of ‘jerk’ is a man who is ‘stupid’ because he does not know how to treat women appropriately).

I will use the concept of FW in my research to look at how the women understand their world as mathematics/engineering students and as middle class, aspirational young Iranian women or family members. In using this concept, I note that the FW some students occupy and construct may be different from others depending on their

particular positioning, trajectory or history in person. In this respect, the notion of FW in Holland et al. (1998) is similar to Bourdieu's concept of 'field', which is also about social spaces that define and are defined by the positions of individuals in a particular context. I will now outline Bourdieu's concept of field in order to illustrate this relationship further, before moving on to discuss how my use of FW modifies that of Holland et al. (1998) in light of this comparison between the two concepts (FW and field).

#### 4.2.2.1 Bourdieu's Concept of Field

Bourdieu defines field as a social space which encompasses the "environment that participants occupy" (White, 2014, p.40). In the quote below, Bourdieu presents the concept of field as a 'force field' comprised of positions of power whereby individuals 'bring to the competition all the (relative) power at their disposal'. In other words, a field is defined as a series of related positions which individuals occupy (positions that are related to one another according to power). The field preserves inequality in that it is defined by who has power (dominant) and who does not (dominated): through practice, individuals enact positions "for the transformation or preservation of the field".

> *A field is a structural social space, a field of forces, a force field. It contains people who dominate and people who are dominated. Constant, permanent relationships of inequality operate inside this space, which at the same time becomes a space in which the various actors struggle for the transformation or preservation of the field. All the individuals in this universe bring to the competition all the (relative) power at their disposal. It is this power that defines their position in the field and, as a result, their strategies (Bourdieu, 1998, pp. 40-41).*

Moreover, inequality is not only apparent within a given field (like education) but though its relation to the 'field of power'. Bourdieu (1998) uses the term 'the field of power' to refer to the broader structure of society as a whole (the objective socioeconomic system), and argues that the relationship between the 'field' and the 'field of power' produces and reproduces positions of dominance and dominated. Choudry et al. (2016) simplified this argument and they say that:

> *The field of power refers to the objective socioeconomic system of production-and-consumption (and distribution and exchange) that allows the dominant classes to oppress the dominated. It is always the relation between the local instantiation of dominance in a cultural field and the field of power as a whole, which Bourdieu argued reveals the objective relations of dominance in the local (p.5).*

Therefore, it is these power relations that position individuals within the field and define who has the right to do what; as such, positions in the field are not equally distributed. In other words, systems of hierarchy, which define positions in relations of dominance/dominated, manifest inequality in a given field. In my research, the position of men and women in the field of education and/or the labour market is of interest, where men are traditionally positioned as dominant in relation to female students as dominated. I am also mindful of the social class position of the women I have interviewed and how this may mediate their choices, experience and aspirations. According to Bourdieu (2001) in Masculine Domination, gender and class cannot really be separated since gender is another manifestation of class in terms of exploring relations of dominance/dominated in a given field. Therefore, in this research, I will explore the intersection of gender and class as I analyse the students' narratives and consider their access to engineering/mathematics as a potential form of capital (see below).

#### 4.2.2.2 Integrating Field with Figured Worlds

Both FW and field see positions as constantly enacted, produced and contested through practice. So the position one holds is not determined entirely but produced and reproduced through practice. In this research, I have opted to use FW, since Holland et al. (1998) give more emphasis to the individual's agency (see below), which suggests that one can change the FW/structured positions available to them. This is not clearly the case in Bourdieu's account of field. However, as noted above, the concept of field in Bourdieu is always related to relations of power (between dominant and dominated) rather than a description of the cultural meanings at work and the effects of such meanings. This point is made by Choudry et al. (2016) below:

> *The truth is, thus, that Bourdieu's approach (in Homo Academicus) and methodology is almost always concerned with explanation of power relations in a given cultural field, rather than with its description per se, or a description of its effects. He sees each cultural field as a particular realization of, or cultural refraction into, the local cultural space (at a particular time and space, i.e. a moment in history) of the field of power (Choudry et al., 2016, p.5).*

As such, Choudry et al. (2016) argue that there are weaknesses in Holland et al.'s (1998) concept of FW in that it does not adequately recognise how power is used and also over-emphasises the local production of cultural spaces. Bourdieu, on the other hand, accommodates the relation between localised practice and the objective structure of society through the notion of the field of power. This argument is important for my study, since I am interested in understanding how structural relations and ideologies regarding women in Iranian society and their access to mathematics/engineering are manifest in the subjective accounts of the participants as they narrate the FW they participate in. Therefore, my use of FW here will try to accommodate relations of power, and I will particularly utilise the concept of 'capital' from Bourdieu in order to explore how localised FW are related to structural relations of dominance and dominated (see section 4.3.3 below).

### 4.2.3 Cultural Models

Another concept I use from Holland et al.'s (1998) work is the notion of 'cultural models', which are socially shared beliefs/values which inform our actions/behaviours. They appear in individual narratives but are also distributed across time and space (sometimes within local groups (e.g. amongst students on a mathematics programme) and sometimes across wider societies (Bruner, 1986). "Cultural models are stereotypical distillates, generalisation from past experience that people make" (Holland et al., 1998, p.55). Cultural models have been analysed with emphasis on symbolic terms, beliefs and values which are rooted in society and family background. For example, in this context, beliefs such as 'mathematics is a lower status subject' or 'mathematics students are failed engineers' will be explored as the kind of social beliefs about mathematics/engineering that might be prevalent. Similarly, there are also cultural models regarding women and their expected

trajectory through life in operation in Iran, as I have outlined in Chapter 2. For example, I have talked about the position of women in Iran in terms of being a 'good educated Muslim woman' which is a cultural model which encompasses both a religious expectation and the values of the Iranian middle class which emphasises educational achievement.

As a result, cultural models are identified here as socially shared symbolic terms, beliefs and values as are rooted in society and family background which, in this case, are drawn upon and used in self-authoring. For this study, these cultural models are part of the FWs of studying mathematics and engineering at university, and the imagined world of being a successful woman in future. As a result, cultural models are the beliefs, resources and stories which make up the cultural realm of interpretation, which is part of the definition of FW as I present above. I will use this concept to analyse my participants' interviews in order to map out how they position themselves in their respective FW and what cultural models they draw on to do so.

### 4.2.4 Positional Identity

As noted above, the concept of position is central to identifying FWs since the latter are largely comprised of a set of positions which constitute and mediate what holds symbolic meaning. Holland et al. (1998) take this notion one step further by referring to Positional Identity, which relates to "behavior as indexical of claims to social relationships with others. They have to do with how one identifies one's position relative to others, mediated through the ways one feels comfortable or constrained, for example, to speak to another, to command another, or to enter into the space of another" (Holland et al., 1998, p.127). In other words, positional identity is a specific kind of identity which builds up through the enactment of relationships with others in a given FW. Holland et al. (1998) argue that such positions become internalised through enacting them in practice: "Social positions, in other words, become dispositions through participation in, identification with, and development of expertise within the figured world" (p.136).

The notion of positional identity again draws on Bourdieu's concept of class position in a given field. For instance, Holland et al. (1998) state that: "Social worlds are

‘organised about positions of status and influence and the cultural narratives that posit particular sorts of characters and their dealings with one another" (p.59). This reference to Bourdieu is noted by Williams (2011) who says:

> *From Bourdieu they [Holland et al 1998] borrow and reshape notions of habitus (embodied ‘history-in-person’, and culture written on the body that constrains and affords a space for action and agency) and field (the field of power shaped locally in the field of structured practices by a set of objective relations between ‘positions’ in the field or ‘figured world’ invoking ‘traditions of perception’, Holland et al., p.41).*

As such, I argue that the concept of positional identity is useful because it helps to consider how the identities narrated in interviews might be connected to localised structural relations. In the process of analysing my data, I am interested in exploring how the women position themselves as engineering/mathematics students and as middle class educated women in Iranian society (i.e. the kinds of positional identities they narrate). I am also interested in how they narrate the positional identities of others (e.g. fellow students, family members, etc) and how they construct themselves as positioned by others in their narratives. For instance, families may be seen to position the participants in particular ways, which may be aligned with or resisted by the student.

### 4.2.5 Self-Authoring

Holland et al. (1998) refer to the process of constructing and enacting identities as self-authoring which encompasses both subjectivity in the moment and an individual’s history (history in person). Individuals "author the world" by "putting words to the world" (Holland et al., p.170) and they "make sense of the world by telling stories about it" (Bruner, 1996, p.130) for others. In the interview situation, I have encouraged the participants in this study to self-author (i.e. to reflect on their identities and experiences). This means they are drawing on their history and also their present experience of being a female mathematics/engineering student answering questions about their identities. So, the concept of self-authoring means we can think about how the women tell of their choice to study mathematics or engineering by drawing on cultural models, but also how they author themselves to

me as the audience in the interview situation. It allows me to think about my role in the dialogue and how I shape their stories. Drawing on Bakhtin's concept of addressivity, Holland et al. (1998) argue that:

> *The world must be answered - authorship is not a choice - but the form of answer is not predetermined. Authorship is a matter of orchestration: of arranging the identifiable social discourses/ practices that are one's resources... in order to craft a response in a time and space defined by others' standpoints in activity (p.272).*

For instance, in my analysis of the participants' narratives regarding their future aspirations after studying mathematics/engineering at university, I have sought to understand my role in the conversation and the extent to which this impacts what they say and the extent to which they try to construct a sense of agency in narrating their future plans. This is most notable in Chapter 8 where some of the participants discuss their plans to move abroad.

### 4.2.6 Agency

As noted above, the concept of agency in Holland et al.'s (1998) approach was a key reason in my choice to use this framework. In considering how structural conditions in Iran are present in interviews I conducted with my participants, it was important that I did not assume this to be a relationship of structural determination. This aligns with Cultural Historical Activity Theory which recognises structures as mediators of experience in activity rather than pure determinants. How individuals respond to such structural conditions may vary in accordance with class position, but also their unique 'history in person'.

Agency is defined by Holland et al. (1998) as rooted in FW which can serve to motivate new actions on the part of storytellers so that they align themselves with a particular position; or, paradoxically, they may offer a space to create alternative possibilities which encourage escape or a withdrawal from action (resistance). In other words, agency may be about inventing new forms of action or challenging cultural norms which bring about new forms of identification. An example of challenging social norms and thus exerting agency in Holland et al. (1998) comes from the chapter about the FW of US college dating (mentioned earlier), where one

woman, Susan, tries to resist the normative rules regarding attractiveness. Susan resists the culture of having a boyfriend as a source of prestige, and Holland et al. (1998) suggest her distance and freedom from the FW of romance shows a sense of agency in rejecting its socio-normative rules and relations. In this respect, Holland et al. (1998) include in their definition of agency notions of freedom and 'individual resistance', which are ever-present even in daily routine life activity:

> *The assumption of homogeneity deflects attention from the social conflict, the social symbolism of knowledge, and individual appropriation and individual resistance, which are important even in an everyday activity like romance (p.122).*

To relate this to my research, through the interviews with my participants, I have collated different life stories which involve different key events/beliefs and FWs figured worlds. Using this framework, I have looked at how the women's narrative stories about their choice to study these subjects serves to enact a position in relation to traditional values or what we might see as a FW of gender relations in Iran. For example, in Chapter 2, I identified a cultural model regarding 'male superiority over women' which had been detected in Iranian textbooks (Paivandi, 2008). Therefore, by using Holland et al.'s (1998) theory in analysing the women's narratives, I anticipate being able to understand their degree of freedom from these kinds of beliefs. This includes exploring whether some women's choice of degree programme is narrated as a means of escape from a FW pertaining to gender relations, and/or involves creating a new FW which challenges social norms (agency).

### 4.2.7 Improvisation

To explore different forms of agency, Holland et al. (1998) distinguish between two concepts: improvisation and world-making. Improvisation refers to the exertion of agency to motivate new forms of action which create alternative possibilities to get round a particular problem or conflict. Such problems or conflicts are brought about by a mismatch between the habitus and field which arises when we are in a situation that we do not have a set response to. Thus, the action of the woman 'who climbed up the outside of the house' to be interviewed by Holland and Skinner on a second floor balcony was an improvisation which addressed a particular conflict: her desire

to be interviewed (habitus) and, therefore, travel to the roof of the house, conflicting with her status as a low-caste person in a high-caste household (Holland et al., 1998, cited by Williams, 2011). Her improvisation is a solution which avoids the social consequences of traversing through the kitchen of a high caste household. Whilst such momentary actions may not change the social structure on their own, Holland et al. (1998) argue that, if improvisation happens continuously from time to time, change will then occur. This claim is stated below:

> *Improvisations are the sort of impromptu actions that occur when our past, brought to the present as habitus, meets with a particular combination of circumstances and conditions which we have no set response. Such improvisations are the openings by which change comes about from generation to generation (p.17).*

According to Holland et al. (1998) "constructivists think of improvisation as an expected outcome when people are simultaneously engaged with or pushed by contradictory discourses" (p.17). In this study, therefore, improvisation can help me to understand how the contradictory discourses, which I identified as prominent for middle class women in Iran in Chapter 2, enabled or pushed the need for improvisation in the women's account of their imagined future. Therefore, understanding how the participants attempt to get round the structural gendered barriers in Iranian society in order to become mathematics/engineering students is a crucial focus for this research.

### 4.2.8 World-Making

World-making, on the other hand, is about challenging and then changing the social norms of society and therefore, the structural power relations at play. Building on Vygotsky's theory of play and imagination, a key concept in Holland et al.'s (1998) research is the use of existing cultural resources (figures and cultural models) to bring about change in the social structure. In this 'serious play', identities are "assembled from, and in relation to, cultural resources" (Holland et al., p.289).

> *...Through serious play, new FW come about... Symbolic competencies, upon which adult life depends,... the activities of 'free expression' the arts and rituals created on the margins of regulated space- develops new social competencies in newly imagined community.The new 'imaginaries' build in their*

> *rehearsal a structure of disposition, a habitus, that comes to imbue cultural media, the means of expression, that are their legacy (p. 272-3).*

The example of world-making offered by Holland et al. (1998) refers to the Tiij festival where the women of Nepal could come together and sing songs about their oppression at the hands of men. Gradually, through engaging in world-making, they begin to work together to find strategies for overcoming such oppression. In doing so, the Tijj festival FW changes and becomes a more political space rather than simply an opportunity for the women to socialise. Therefore, I argue that world-making is evident where people see themselves in a new imaginary world where they can transform the existing social structures of what is currently experienced.

In Chapter 2, I have identified a number of ideological contradictions, for instance, 'gender discrimination' in the labour market in Iran versus the desire to increase the education of women, particularly in mathematics and engineering. In analysing the participants' narratives in this study, I have looked for indications of a desire to overcome gendered oppression in Iran and/or the use of new or existing cultural models and figures to imagine a different or new social positioning and structure. Therefore, I argue that this theoretical framework allows me to explore how my participants may position themselves in relation to other social factors which are embedded in the social structure (i.e. cultural models or beliefs, figures - individuals who are either real, e.g. parents, or symbolic, e.g. a good teacher -, and grand narratives/discourses which map out expectations/events for individuals, etc).

## 4.3 Using Bourdieu

Above, I have outlined the theoretical framework for the study by focusing on key concepts proposed by the theoretical perspective offered in Holland et al. (1998). Throughout, I have highlighted why this framework is appropriate to my research, but I have also indicated some weaknesses in such a framework. Particularly, this relates to the extent to which the framework can recognise structural conditions operating in localised practices, and thereby at the level of students' narratives. I have suggested that, to accommodate this, I need to expand Holland et al.'s

framework to include further insight from Bourdieu's critical social theory. Bourdieu's social theory is particularly suited to this thesis because I am interested in gender which, as the literature in Chapter 3 shows, implicates issues of inequality and unequal access to high status positions in society. Bourdieu's theory largely focuses on how structural inequalities are maintained and reproduced over time, from generation to generation, through localised practices which enact a distribution of social relations of dominance and dominated. Also, through his notion of misrecognition, he explains why people may act in ways which contribute to processes which reproduce inequality, even at the expense of their own interests (Bourdieu and Passeron, 1990). For instance, in the Iranian context, we know that many women have voted for the Islamic Republic since 1979, yet doing so has, at times, brought more inequality for them, as highlighted in the resurgence of traditionalism period in Chapter 2. It is worth mentioning here that women in Iran were first allowed to vote in 1963 under Mohammed Reza Shah's throne (Afkhami, 2004).

In the case of this research, I am interested in why female engineering students choose to study courses that are (in some cases) male dominated (i.e. EE) and which result in labour market destinations, which are permeated by gender discrimination. Therefore, I need to expand the theoretical framework I have outlined above in order to look at potential mechanisms of inequality in relation to gender. Here, I argue that Bourdieu's theory can help to critically 'see' how inequality is experienced and narrated by the women in this study.

### 4.3.3 Capital

I have chosen to focus on Bourdieu's concept of capital as a way to explore such mechanisms of inequality in the participants' narratives which, I argue, allows me to see structural relationships at work at the local level. This concept is not explicitly used by Holland et al. (1998) and I suggest that my doing so allows me to address the critique raised by Choudry et al. (2016) regarding the notion of FWs being too localised (see above).

Bourdieu uses the concept of capital in order to show that inequality (different classes) exists because of the specific distribution of resources accessed by various positions in a given field. He defines capital as:

> *Capital is accumulated labor (in its materialized form or its 'incorporated', embodied form), which when appropriated on a private, i.e., exclusive, basis by agents or groups of agents, enables them to appropriate social energy in the form of reified or living labor (Bourdieu, 1986, p.241).*

As can be seen above, Bourdieu (1986) is using the metaphor of capital in a particular way where he says that, in any field, there are resources that are valued. He notes that such resources are the product of labour accumulated over time, which suggests that capital is both continuously acquired by those able to engage in the process of capital exchange through labour, and concentrated amongst certain groups or positions in the field (dominating positions). On the idea of private and exclusive, capital exchange occurs privately, hidden from public view, through practices which are considered normal, natural and, in so far as it is concentrated towards those occupying dominant positions in the field, it is also exclusive (i.e. not available/attainable for all).

In Bourdieu's (1991) book *Language and Symbolic Power,* he likens capital to playing a trump card in a card game, where those in possession of the trump card (i.e. that which ranks above other cards) are more likely to win or profit:

> *The kinds of capital, like trumps in a game of cards, are powers which define the chances of profit in a given field (in fact, to every field or sub-field there corresponds a particular kind of capital, which is current, as a power or stake, in that field) (p.230).*

As such, capital encapsulates the resources exchanged by those in dominant positions to reproduce relations of dominance/dominated.

Bourdieu (1986) divides capital into three parts: economic capital, cultural capital and social capital. Economic capital is related to money (financial capital) and can also be seen in the forms of property rights (ibid). Economic capital is also defined by Marx, who stated that economic capital is acquired by the capitalist through the production and sale of the commodity, and thus enables control of the dominated

labour force (Marx, 1976). The capitalist invests economic capital in the production of the commodity by paying the worker to invest their labour power in production. But the exchange value of the commodity always supersedes the initial capital invested, enabling capitalists to profit from the labourer's time. This profit leads to the accumulation or growth of economic capital. In this study, the economic capital the women have access to (e.g. in terms of financial support from families) may be of relevance in their narratives, as it may mediate their choice of degree, institute and their future career aspirations.

#### 4.3.2.1 Cultural Capital

Unlike Marx, Bourdieu's concept of capital also places emphasis on the cultural resources that are exchanged within a given field and the symbolic value they hold (rather than financial value). In this sense, "Bourdieu's perspective can be seen as extending Marx's critique of capital in to the cultural fields, including education" (Williams et al., 2016, p.5). Cultural capital "in a wider sense can refer to the type of culture or cultures existing within the field" (White, 2014, p.51), since what holds cultural capital depends largely on what is given symbolic value in that field. The relationship of the field to the field of power determines the extent to which capital has transposable value outside of its field. For instance, given that the field of education lies close to the field of power, cultural capital accumulated in the educational field holds transposable value (e.g. qualifications) which can be exchanged for profit in other related fields (e.g. the job market).

Furthermore, "Cultural capital can be acquired, to a varying extent, depending on the period, the society, and the social class, in the absence of any deliberate inculcation, and therefore quite unconsciously" (Bourdieu, 1986, p. 188). This quote emphasises that the exchange of capital is embedded in and through 'naturalised' practice, spurred on by the alignment of the habitus to the field. It therefore does not require conscious control or attention but is that which is unrecognised as capital. In the quote below, Bourdieu refers to this as symbolic capital, which is the "degree of accumulated prestige, celebrity or honour and is founded on a dialectic of knowledge (connaissance) and recognition (reconnaissance)" (1993, p.7). Below, he also discusses symbolic capital as that which is seen as 'legitimized competence' which

exerts the effect of misrecognition – an apparently natural order that does not question processes which actually manifest an unequal distribution of capital.

> *Because the social conditions of its transmission and acquisition are more disguised than those of economic capital, it is predisposed to function as symbolic capital, i.e., to be unrecognized as capital and recognized as legitimate competence, as authority exerting an effect of (mis)recognition, e.g. in the matrimonial market and in all the markets in which economic capital is not fully recognized, whether in matters of culture, with the great art collections or great cultural foundations, or in social welfare, with the economy of generosity and the gift (Bourdieu, 1986, p.188).*

In my study, I will investigate the presence of capital exchange as a 'natural' process which is not necessarily recognised as such by the participants. According to Bourdieu (1986), cultural capital can be transformed into economic capital:

> *It can immediately be seen that the link between economic and cultural capital is established through the mediation of the time needed for acquisition (p.247).*

Here, Bourdieu argues that the different forms of capital are related since economic capital can enable the accumulation of cultural capital and vice vera. For example, the achievement of a particular qualification in the education field is a culturally valuable resource (cultural capital) which can then be exchanged for economic capital in the employment market over time. The key point is that capital enables one to grow capital through a series of exchange relations which occur through practice in a given field, thus always reproducing an advantaged position. Williams (2011) also highlights how Bourdieu's notion of cultural capital draws heavily on Marx's concept of exchange value:

> *Bourdieu emphasizes exchange values or what he calls 'cultural capital' in fields, such as 'educational capital' in the educational field, and identifies this with class re-production (Williams, 2011, p.58).*

Therefore, he suggests that Bourdieu presents a cultural conceptualisation of exchange capital which differs from Marx's purely economic use of the term. Marx's notion of exchange value is about exchanging a commodity for money, based on the commodity representing the labour that produced it. For example, if I pay a financial

sum for the latest iPhone, this amount must cover the cost of the labour of producing it (plus the raw materials) and must also include some profit for the capitalist who owns the means of production. In Bourdieu, this exchange value takes on a cultural form and consequently profit is translated into prestige, power and more capital (capital growth) for those in dominant positions in the field. The connection with class position here (in the field of power) is that position defines what capital one has access to and the extent to which one can exchange such capital 'in practice'. The point, here, is that the exchange value of capital is symbolic and not material or financial.

#### 4.3.2.2 Social Capital

The final form of capital Bourdieu refers to is social capital. According to White (2014, p.47) "when capital is transferred from the field to the habitus through social networks, it is referred to as social capital". Social capital is normally defined by the resources based on relationships and members in a particular group:

> *Social capital is the aggregate of the actual or potential resources which are linked to possession of a durable network of more or less institutionalized relationships of mutual acquaintance and recognition-or in other words, to membership in a group-which provides each of its members with the backing of the collectivity-owned capital, a 'credential' which entitles them to credit, in the various senses of the word (Bourdieu, 1986, p.248).*

From the quote above, we can understand that, through access to social networks which hold social capital, an individual can acquire cultural capital (capital growth). Having the right kind of network is important and this again is defined by the field. So, for example, the middle class child is likely to have access to a family network who have held higher positions in the educational field and thus can ensure the child engages in the kinds of activities which are deemed important by the educational field (cultural capital). So, the social network mediates access to cultural capital in this case. Thus, Bourdieu sees social capital as a social opportunity which emerges through enacting relationships with others in a way that facilitates capital exchange through practice.

> *Bourdieu understands social capital as providing access to cultural capital which enacts one's position in the field. In so far as these positions are defined by relations of power, in that they enact dominating and dominated class positions, social capital can be said to be defined by class position. As with cultural capital, social capital is also defined by the field in which it holds value, and may offer transposable capital to the broader field of power depending on the relation of the more localised field to the broader field of power. For instance, access to social capital in the educational field might involve acquiring a network of people who work in education (e.g. tutors or like-minded friends) who can provide access to resources (cultural capital) which facilitate capital exchange (passing qualifications). As mentioned before, this process of capital exchange produces profit that is transposable from one field to another because of the status of the educational field in relation to the field of power.*

In this research, Bourdieu's concepts of economic, cultural and social capital will be used to understand the cultural resources which underpin my participants' choice of degree, their experiences of studying mathematics/engineering and their future aspirations. I will seek to understand the specific symbolic form that these different forms of capital take, which I argue appear as cultural models (normative beliefs about who can access what) and how they are mediated by the Iranian context in which the women are situated. To do so, I need to understand the FW in which capital exchange is situated - chapter 2 has helped in part by providing information which may help me to work this out. As such, it is the coming together of the Iranian cultural-historical information in Chapter 2 (objective structures) with the cultural meanings ascribed in the women's narratives (subjective meaning) that allows me to understand how the Iranian context mediates the women's access to capital through their enrolment in mathematics and engineering programmes.

### 4.3.4 Why not Bourdieu?

Whilst Bourdieu offers the above concepts which are useful to my framework as a means to explore how gender and inequality is produced in practice, several scholars have criticised this theory as being too deterministic, offering little room for agency (Choudry et al., 2016: William, 2011: White, 2014). Although Bourdieu does discuss agency in his writings on reflexive sociology, where he argues for the importance of critical sociology in revealing the structures of society produced through practice as a means to achieve social change (Bourdieu, 1977), much of his work gives little

space for the majority of individuals to challenge the system of capital exchange they are exposed to, largely because it is unrecognised in its symbolic form (as outlined above).

> *Conditioned and conditional freedom the habitus secures is as remote from the creation of unpredictable novelty as it is from a simple mechanical reproduction of the initial conditioning (Bourdieu, 1977, p.95).*

So, whilst Bourdieu argues that individuals can enact, produce, and contest positions through practice (which involves some agency), he does "not enable the necessary focus upon the potential for agency that is required of this conceptual framework" (White, 2014, p.55).

In this way Williams (2011, p.131) argues that "Bourdieu's point of view on agency involves strategic improvisation within a limited range of possible choices". This is problematic for my research as, given the conflicting ideologies at work in Iranian society as outlined in Chapter 2, I am interested in exploring how the female participants in this study experience and resolve such contradictions in their own narratives. So, whilst I am interested in how participants' stories manifest class positions and access to capital, I am also interested in how they navigate conflicting positions and expectations, which I argue are likely to be apparent given the context in which these women are situated. For this reason, I have primarily used the theoretical perspective offered by Holland et al. (1998) but have expanded this to focus on capital as a means to see structural relations enacted at the local level.

## 4.4 Summary of the Theoretical Framework

To summarise, in this study I analyse the women's narratives using the conceptual framework (cultural models, figured worlds, world-making, etc) in order to look for similarities and differences amongst the stories and to explore the extent to which the women are positioned by the dominant beliefs outlined earlier or whether they have agency in resisting or transforming such beliefs. In doing so, I can begin to compile a picture of what/who are the beliefs and figures in the women's stories about their choice of degree, their experience of studying at university (present), and their future aspirations. In doing so, I can look at what factors enable/hinder their agency in a

context where both culture and policy can potentially be seen as deterministic. For example, the stereotype that mathematics-engineering is better suited to men or gender discrimination in the workplace/recruitment are often defined as cultural barriers by many in Iran and in western contexts (Chapter 2).

With this framework, I can avoid notions of cultural/structural determinism and consider the sense of agency in the women's narratives, which allows me to understand the complexity of their positioning of themselves (as well as being positioned by others) in relation to the structural framework in Iran. Structural determinism means that structural relations (e.g. inequalities between men and women) determine who can do what. The individual is passive and is simply 'made to act' by the structure and their position in it. By using Holland et al. (1998) and Bourdieu (1986; 1991; 1997; 1998; 2000), I can argue that, whilst structures do have a powerful influence on what we do, we are also agents and free to a certain extent to manipulate or change the structure. We never act outside of the structure with complete freedom, but we are also not completely defined by it - we are able to use our agency to change it either in a small way (improvisation in the moment) or in a bigger way (world-making through political mobilisation). This is important in my work because the women I have interviewed are immersed in a cultural context where change (big and small) occurs consistently due to the kinds of contradictions and conflicts outlined in Chapter 2, I argue that my use of reflective interviews has encouraged participants to offer narratives regarding their identities which have allowed me to see this sense of agency in their own words.

Using this theoretical perspective and framework allows me to build on a number of studies which use a similar approach to study gender and participation in STEM. These also use concepts such as identity, positionality, FW, challenge and agency, and include: Braathe et al. (2014), Black et al. (2012), Williams (2011), Solomon et al. (2011) and Solomon (2012). These studies have formed the basis on which to build my research, since they also focus on the position of women in relation to mathematics/engineering courses at university. However, my study has two key differences from this body of work: a) I am investigating students studying in an Iranian context (the studies all focus on the UK or Europe); and b) I am also using Bourdieu's forms of capital which are not extensively used by those listed above.

Similarly, whilst studies such as Archer et al. (2012, 2014), use the notion of capital (c.f. science capital) to explore inequality in science aspirations, they omit the significance of identity in exploring students' choices and aspirations (see critique made by Black and Hernandez-Martinez, 2016).

## 4.5 Research Questions

I am interested in how my participants value the degree programmes they are undertaking and how such values connect to their location in the social, cultural and historical context of Iran, and the extent to which they express a sense of agency within this context. Therefore, this study's RQs are seeking to investigate 1) the forms of capital apparent in the women's narratives and 2) the sense of agency in their account which are shown below.

The questions below were developed through my consideration of the research literature which has been outlined in Chapters 2 and 3. Chapter 3 focuses on world-wide literature (mainly UK/US), where the lower participation of female students in STEM subjects has been analysed extensively. This body of literature suggests that issues of choice, experience of the degree programme and students' aspirations are central in explanations of female under participation, all of which are mediated by socio-cultural factors. Therefore, I initially began my study with a first set of RQs which emphasised students' choice, experience and future aspirations. However, after developing the theoretical framework outlined in this chapter, I felt the need to incorporate concepts which allowed me to see the social context of Iran at work in the women's narratives. Therefore, I re-constructed the RQs in order to allow me to use the key concepts outlined to best effect in reading and interpreting the data. This largely involved the introduction of capital and agency into the RQs:

- RQ1. How the cultural-historical-economic structures and conditions of Iran manifest in Iranian female STEM students' narratives regarding their choices, experiences and aspirations?
    - RQ1a: What forms of capital are apparent in female students' narratives about their choices, experiences and aspirations?

- RQ2. How do Iranian female STEM students position themselves in relation to such contextual conditions?

    - RQ2a: In what ways do female STEM students display a sense of agency in their narratives about their choices, experiences and aspirations?

## 4.6 Conclusion

I used these two theories to understand how I can explain the increasing number of women in STEM in Iran. Therefore, by conducting such theories, I tried to understand the effect of the structure of society on women's attitudes towards STEM-the structure of society discussed more by Bourdieu and women's attitudes as an agent explained by Holland et al. (1988). As a result, I have applied these theories to recognise how I can define the impact of society on individuals in the participants' narratives in the unjust society. In the next chapter, I will discuss the qualitative research design and analysis which seeks to explain the concepts that are useful in understanding qualitative research, such as critical inquiry, which will add to our current understandings of gender and STEM participation in the Iranian context.

# Chapter 5: Methodology and Data Generation

## 5.1 Introduction

The purpose of this chapter is to outline the methodology for the study and the methods for collecting and analysing the data. In this respect, I will report on the research paradigm in which the study is located, including my epistemological and ontological standpoint and the research design, which justifies why a narrative approach has been used. The relation between the theoretical stance and a methodology which centres on narrative inquiry will be outlined in order to justify how this approach can be used in combination with my theoretical framework. This chapter, therefore, builds on Chapter 4, where I have discussed the key concepts that form the theoretical framework and how they are operationalised in this study. I have piloted the use of this theoretical framework to analyse similar interview data to that which I collected (my analysis and reflections on the framework can be found in Appendix 8). Moreover, I will outline the process of selecting participants for interview using an initial exploratory phase, where a brief survey was used to scope the range of students' experiences regarding their choice of degree programme and aspirations. Here, reasons will be provided for why participants were approached and recruited based on their response to a short survey and pre-data collection meetings. I will also discuss: establishing trust with the participants during recruitment and when conducting the interviews; initial plans for analysing the interviews using a narrative approach; and the ethical issues raised in this research.

## 5.2 Research Paradigm

A research paradigm relates to the way the research views relations in the world or, in other words, a "general orientation about the world and the nature of research that a researcher holds" (Creswell, 2009, p.6). The research paradigm can be seen as

epistemology and ontology (Crotty, 1998), which define the methodological position in a broader context (Creswell, 2009). Epistemology and ontology refer respectively to 'the theory of knowledge' and the theory of how things are in the world which is embedded in the theoretical perspective and methodology (Crotty, 1998). According to Bruner (1987), epistemology is not just what is known but rather how we construct knowledge about reality, and thus epistemology is a statement by which to judge the validity and reliability of findings. Ontology, on the other hand is how one 'sees' reality, or rather how one understands the existence of the social world. Ontology 'would sit alongside epistemology informing the theoretical perspective, for each theoretical perspective embodies a certain way of understanding what is (ontology) as well as a certain way of understanding what it means to know (epistemology) (Crotty, 1998, p.10).

The most common paradigms that reflect the fundamental ontological/epistemological perspectives in the social sciences are according to Crotty (1998): positivism/post positivism, interpretivism/naturalistic, and critical inquiry (Crotty, 1998). Firstly, positivism holds that "what is posited or given in direct experience is what is observed, the observation in question being scientific observation carried out by way of the scientific method" (Crotty, 1998, p.20). Ontologically, positivism seeks to observe reality on the basis of rationalist principles which seek to identify mechanisms which can be accessed through systematic methods in the form of cause and effect (Denzin et al., 2008). By contrast, "Those who engage in qualitative research using a belief system grounded in post-positivism will take a scientific approach to research" (Creswell, 2007, p.20). Those who adopt this approach to qualitative research "believe in multiple perspectives from participants rather than a single reality, and espouse rigorous methods of qualitative data collection and analysis" (ibid). Significant differences have been found between positivism and post-positivism, described by Denzin et al. (2008, p.14):

> *In the positivist version it is contended that there is a reality out there to be studied, captured, and understood, whereas the postpositivists argue that reality can never be fully apprehended, only approximated.*

Many who conduct qualitative research apply either interpretivism or critical inquiry as an epistemological perspective in their research. According to (Denzin et al., 2008, p.31) interpretivism, or what he terms as a naturalistic approach, "is guided by the researcher's set of beliefs and feelings about the world and how it should be understood and studied". Here, reflexivity on the part of the researcher is essential to making such beliefs visible in the researcher. This is justified since interpretivists ontologically recognise multiple realities and perspectives whereby no one, individual reality is 'true', hence one might reflect on the relative nature of what is 'true' to any one individual. According to Anfara (2002), a good naturalistic researcher tries to reveal the meanings individuals give to a phenomena and a hidden world which underpins such meanings, as "behind every closed front door there is a world of secrets" (Oakley, 1981, p.41). Finally, critical inquiry refers to an ontology and epistemology which recognises that truth about this world is driven by its sociality since the social world "is made up of feeling, thinking human beings, and their interpretations of the world must be studied" (Denzin et al., 2008, p.17). Critical here is not referring to criticising but instead "… refers to a transcendental realism that rejects methodological individualism and universal claims to truth" (Denzin et al., 2008, p.17).

The approach adopted in this thesis relates to critical inquiry since, by applying social theories such as those of Bourdieu and Holland et al. (1998), it seeks to establish how social meanings manifest critical, ideological values which are produced and reproduced at the macro level. As noted in the previous chapter, Bourdieu's framework helps us to see how the reproduction of inequality is endemic in all forms of practice and the relations between them, whilst Holland et al. (1998) offer the tools to look for agency, whereby freedom from processes of reproduction is exerted. In this research, by using Holland et al.'s (1998) framework, I am able to explore whether some women's choice of degree programme is narrated in ways which evidence the exertion of agency in relation to structural gender inequalities. Similarly, Bourdieu's (1986) concept of capital offers the conceptual tools to critically examine women's access to STEM in HE in a context such as Iran, where inequalities around gender are a concern. This involves recognising and also critically challenging social norms, and thereby aligns with Crotty's (1998, p.157) understanding of critical inquiry, where the goal is to build a society based on

justice, freedom and equity which 'may appear utopian'. I am thus supporting "a social science that is committed up front to issues of social justice, equity, nonviolence, peace, and universal human rights" (Denzin et al., 2008, p. 18). Furthermore, Crotty (1998, p.158) argues that "critical inquiry illuminates the relationship between power and culture and, in this picture of things, culture comes to be looked upon with a good measure of suspicion". In this study, I act as the critical researcher, attempting to unpack how structural inequalities, which are particular to the Iranian context and its history of political change (outlined in Chapter 2) are manifest in female mathematics and engineering students' interviews. In doing so, I seek to understand the effect of historical, cultural and social context (including policy changes) by studying power relations embedded within culture (e.g. male/female power relations or those operating within families), and then to the individual. Therefore, my use of critical inquiry is to recognise the social world as mediated by such power relations which are then manifest in the subjective narratives of my participants.

### 5.2.1 Subjectivism and Objectivism

Bourdieu's (1977) theory is central to my epistemological perspective in this study, which offers particular insights in terms of establishing an ontological framework which is consistent with my theoretical framework. For Bourdieu, ontology involves a dialectic relationship between subjectivism and objectivism. Bourdieu's view of objectivism presented in his book *An Outline of a Theory of Practice* is about recognising the objectivity of practice in society. Uncovering the tacit (unconscious) values operating within a given field can tell us about the objective processes 'in practice', where individuals are the object of the society-social norms and values. By studying processes of norms and values (capital), we adopt a critical view of structured power relations in practice:

> *The knowledge we shall term objectivist constructs the objective relations (e.g. economic or linguistic) which structure practice and representation of practice, i.e., in particular, primary knowledge, practical and tacit, of the familiar world (Bourdieu, 1977, p.3).*

The subjective aspect of research is the experience of the individual which is then studied objectively as situated and contributing to social structures in the world through research. In other words, the participants' recounted experiences in this research are studied as subjective representations within the objective practice of the society which can be recognised in the tacit values of the culture.

Furthermore, Bourdieu (1977) argues that both aspects of subjectivity and objectivity must be explored in tandem in research, as he "recognises that the separation between subjectivity and objectivity is false - both are necessary and essential in building a whole understanding of the research environment" (White, 2014, p.68). In this sense, the subjective and objective are inside one another in dialectic relation: they each mutually inform one another. For instance, in my research, the structures of society in Iran in terms of class positioning and gender is viewed as manifest inside the subjective experiences of the women, but such experiences also contribute to these structures and, therefore, can be studied using theory. As such, evidence regarding particular cultural models, which I will look for in the participants' subjective accounts, also provide evidence of objective structures in practice since they are culturally shared and reproduce norms and values which enact structural relations. So, objective aspects of society can be read in the data which also presents the participants' subjective experiences as contributing to those objective processes.

## 5.3 Role of the Researcher

My role as a researcher has played a significant part in this research: who I am in relation to the women is crucial in terms of establishing the trustworthiness both with participants and in the findings. Trust and friendship can enhance the validity of findings, and my role as an insider can help to improve this matter. As I have studied in an Iranian university, I have attempted to build up trust with the participants in many ways, such as sharing my experiences, showing respect for the participants' opinions, showing how much their knowledge will be useful for the study, and showing the difficulties that I have been faced while I was studying and how these have been overcome. To support this, I gave participants a written account of my story in order to share my life with them as somebody who studied mathematics in

Iran. As discussed in Chapter 1, in 2000 I enrolled as a mathematics student at the University of Najaf Abad. I failed to pass the entrance exam for engineering at university and this led me to enrol on this (mathematics) degree programme. However, I found mathematics an interesting subject and this challenged me to understand students' reasons for choosing these different STEM subjects (i.e. engineering vs. mathematics). My purpose in sharing this account with them was to provide the participants with knowledge of our shared experience and to reveal my positionality in the research from the beginning of the data collection period.

The impact of my efforts to establish trust can be seen in Zahra's case most clearly (see Chapter 6), where she displayed a certain amount of confidence and willingness to talk about family beliefs and problems experienced in her university environment. Perhaps the reason for her confidence in me was that I was not a member of the Iranian university she attended but understood the system and its expectations because of our shared experience. There were other instances during the interviews where the students seemed to be aware that they were revealing issues that they could not say to a male lecturer (e.g. regarding gender discrimination in the lecture theatre). I believe I was seen partly as a female westerner as well as an Iranian mathematics student which, I argue, created a safe space to discuss issues which might be seen as problematic elsewhere (e.g. as shown in later chapters, Hiva spoke of her experience in underground theatre which her family did not know about and Sheida spoke about challenging patriarchal norms - See Chapters 7 and 8). A discussion of the ethical issues this raises can be found in Section 5.10.

In addition, my view as a partial 'insider' also enabled me to understand the women's intended meanings which helped in the interpretation of their interview data. The role of an insider has both negative and positive outcomes. On the one hand, being part of the dominant culture can lead to taken-for-granted assumptions which may be more apparent to an outsider, while, on the other hand, knowing the participants' culture can lead to an understanding of their motivations. For example, prior to the research I had the pre-assumption that mathematics has lower prestige than engineering and that most students would typically choose engineering over mathematics given the choice. However, through the course of the research, I came to realise that not all students follow such beliefs and dominant expectations (like

Zahra). Thus, I had to be aware and reflect on my pre-assumptions (arisen because of my role as a partial insider) during the research process. To do so, I approached the research with an ‘open mind’ in order to be aware of my presumptions and critically reflect on them. This aligns with a critical inquiry approach since, by attempting to stand outside of my own experience, I was able to explore the objective relations that are rooted in structural conditions in Iran and how they are manifest inside my own subjective experiences.

As detailed below in Section 5.8.3, I conducted a pilot study where I analysed interview data collated with a British Asian woman studying mathematics in the UK. The purpose of this was mainly to test out the theoretical framework and its value in answering my RQs. But it also helped me to increase awareness of my own positionality in this research. Through analysing this transcript as someone who is, to some extent, outside of the UK HE culture, I was able to ‘see’ cultural models which may be 'taken for granted' by an insider. Again, this has alerted me to the need to be sensitive to 'taken as shared' meanings or understandings when analysing this kind of data, and the need to use the interviews to make what is unseen or unspoken - seen. This is a key aim behind the critical inquiry approach I have adopted.

## 5.4 Validity and Trustworthiness

According to Patton (2002), validity and reliability are two factors that any qualitative researcher should be concerned with while planning a study, examining results and judging the quality of the study. “Validity deals with the notion that what you say you have observed is, in fact, what really happened. In the final analysis, validity is always about truth” (Shank, 2002, p.92). From a qualitative perspective, the validity and quality of qualitative analysis can be considered in terms of triangulation, credibility, transferability and confirmability. “Triangulation strengthens a study by combining methods” (Patton, 2002, p.247), and allows the researcher to use “different material critically, to test it, to identify its weakness and to identify where to test further doing something different” (Fielding, 1986, p.24). In this study, I have used two different methods of data generation, which include a short survey in the exploratory phase and narrative interviews, and I have considered

how these methods present evidence which highlight similar themes (see Chapter 7). This has allowed me to establish the extent to which themes in the students' narratives are shared by a larger group of students and are not isolated to individual students – a key factor in operationalising cultural models. I have also recruited participants from different degree programmes (mathematics, computer engineering and electrical engineering) and thereby looked for commonalities and differences amongst them, which I argue adds to the validity of the findings.

In order to enhance credibility of this research, a short outline of the participants' stories have been checked with them (see member checking in Section 5.7.4.3) to validate my interpretation. I also checked such summary stories with my supervisor, who also had access to the full transcripts to check the accuracy and validity of my interpretation (this is a form of peer debriefing - Anfara et al., 2002). Also, during the interviews, I continually tried to check my interpretation of their comments as it progressed. The participants were also asked to point out if they were confused by any of the questions, in order to capture their ideas accurately.

To demonstrate transferability, I need to consider how the findings can be applied to other contexts and a broader understanding of women's perspectives of studying mathematics and engineering. In Chapter 9, I discuss this as I situate the findings and contribution to knowledge in the wider literature in this area. This helps to establish the validity of my findings by presenting this case as one amongst many out there in the research field.

Another key aspect of this research is to establish transparency in the data generation process and analysis, so that others can 'see' clearly what was done and how, so that they might adopt or adapt such processes in their own research. With this in mind, I have sought to 'spell out' clearly the data generation process and the analysis framework adopted in this thesis to enable such transferability. I have also provided thick descriptions (Anfara et al., 2002) of the data both in terms of contextual meanings and in the use of direct quotes from the interviews, which can be seen in the analysis chapters. My purpose here is not to enable generalisations from the findings at an empirical level, but to offer evidence that the concepts at work are analytically generalisable across contexts (Yin, 2016).

## 5.5 Research Design

As can be seen from Chapter 4, the concept of identity outlined in Holland et al. (1998) places emphasis on narrative; that is, the stories we tell about ourselves using cultural resources to hand. In my research, I wanted to explore how the Iranian cultural context and the experience of studying STEM in university in Iran as a female was manifest in their subjective accounts of this experience. Therefore, I adopted Holland et al.'s (1998) position that students' experiences can be understood as narratives which are mediated by and manifest in the social, historical and cultural context in which they are situated, and thereby reflect the objective structures of Iranian society. In this sense, my use of narrative in this research serves to operationalise the subjective-objective dialectic mentioned earlier which underpins my epistemological and ontological framework. This has motivated my decision to use narrative inquiry as it involves applying theories such as FW and Bourdieu, which can link individual narratives to wider society as a form of critical inquiry.

The proposed design for this research as a form of narrative inquiry follows Creswell (2007), Bruner (1996) and Lieblich et al. (1998). "Narrative research incorporates many forms, such as autobiography, life stories, and personal stories, as well as biographies" (Creswell, 2007, p.4). The overall aim of this study is to capture the participants' life stories about their choice of degree course, their personal experience of studying mathematics or engineering programmes, and their future aspirations. According to Creswell et al. (2007) life stories portray an aspect of an individual's life; a story which has a beginning, a middle, and an end. Thus, for this study, the approach taken has involved writing about the past (students' choice of degree programme), the present (their experience at university) and the future (their future aspirations both in terms of careers and future life trajectory). Lieblich et al. (1998) argues that narrative research appears as the most effective methodology for capturing a life story as it guides the researcher in interpreting, evaluating and constructing life story materials.

Bruner (1996) also stresses that narrative is a powerful method to explore cultural models which give meaning to individual narratives, in that they connect and situate them in broader social and ideological stories and beliefs ("any single narrative is contingent on a wider set of narratives"; McCabe, 1991, p.3). Meaning-making like this is culturally shaped and highly complex, so narrative inquiry taps into this by looking at social factors from different perspectives. Thus, the advantage of narrative inquiry is that it gives meaning to social beliefs and allows us to understand the complexity of such beliefs in a way that other methods cannot do. For example, a survey about gender stereotypes in relation to mathematics or a survey about women'' attitudes towards studying engineering would not allow me to explore the significance of such stereotypes to the participants' lives, whereas narrative inquiry allows me to see this significance through placing such beliefs in the context of the students' life story.

Therefore, narrative inquiry allows me to see how each student's story is shaped by wider ideological beliefs about the status of mathematics in Iranian society and the values placed on certain forms of HE amongst other things. The meanings co-constructed through these narratives are important if we want to understand the women's choices as culturally and socially shaped by shared beliefs, stereotypes, cultural models etc. Furthermore, narrative deals with 'rich' data as Lieblich et al. (1998, p.9) states that "no two interviews are alike, and the uniqueness of narratives is manifested in extremely rich data". So, whilst there may be common themes in the narratives these women construct through the interview process, there is also uniqueness in the 'lived experience' reflected in each narrative biography. Moreover, a narrative approach is used in much of the literature about women's access to and inclusion/exclusion in mathematics and engineering (Solomon, 2012, 2013; Mendick, 2005a; 2005b; Black et al., 2012; Rokis, 2011; Sonnert, 1995b), which further indicates that narrative inquiry is an appropriate design to use.

### 5.5.1 Aligning Narrative Inquiry with the Theoretical Framework

My use of narrative inquiry aligns the methods of data generation used in this study with Holland et al.'s (1998) focus on narrative identity described in Chapter 4. According to Holland et al. (1998), the idea that our identity (our sense of who we

are) is ‘narrativized’ and ‘dramatized’ conveys the idea that many of the elements of our lives relate to one another in the form of a story or drama: “a ‘standard plot’ against which narratives of unusual events are told” (p. 53). To explore why specific (sometimes unusual) events are told by participants (or why their story is told in a particular way), Holland et al. (1998) speak of such stories as located in and informed by an imaginary world of actors (figures), positions, events, beliefs (cultural models) and stories.

As such, by using narrative inquiry as a methodology, I can begin to compile a picture of what/who are the beliefs and figures in the women’s stories about their choice of degree, their experience of studying at university, and their future aspirations. In doing so, I can look at what cultural models enable/hinder their agency in a context where both culture and policy can potentially be seen as deterministic.

Narrative inquiry has also allowed me to operationalise Bourdieu’s concept of capital which stems from his theory in practice, since the narratives generated through the data collection can offer insights into participants’ habitus and their perception of the field(s). Here, I am mindful of Bourdieu’s formula of ‘[(Habitus) x (Capital)] + Field = Practice’ (Bourdieu, 1984, p.101) and argue that narrative inquiry offers methodological tools to explore such relations (as mentioned in Chapter 4). I argue, here, that narrative inquiry allows me to partly tap into the habitus of the women interviewed and to see how it is shaped by the field. This aligns with what Bruner says about narratives constructing reality: such constructions involve cultural models which mediate and are shaped by the habitus. Bruner (1986) defines narrative within the boundaries of beliefs and ideas, as he mentions that “man is not free either of his genome or his culture” (p. 135). In this way, Bruner (1996) argues that “human beings make sense of the world by telling stories about it - by using the narrative mode for construing reality (p.130).

The reference to cultural models, here, as a resource for one’s narrative identity (see Chapter 4) which then manifests the habitus/field/capital relationships in which individuals are operating, is important. This means that the cultural context in which one is situated mediates the students' perceptions of the world, which, to some

extent, can then be reflected upon through a narrative interview. I say 'to some extent' here because a narrative interview can only be said to manifest Bourdieu's concept of habitus in part, given that the habitus is largely unconscious. But, nevertheless, I argue that it still informs what we are able to consciously reflect on as we story ourselves as certain kinds of people based on restoring the past and building the future. My interviews, therefore, provoke such reflection, so that what may be seen as unconscious is brought to consciousness as the women story their experiences.

## 5.6 Interview Sample

The analysis presented in this thesis focuses mainly on narrative interviews with 7 female students in mathematics and engineering courses at Jesus University in Iran (pseudonym). As outlined below, I report on some survey data but this was used essentially as a sampling recruitment tool (see below). Jesus University is a public university which is situated in Tehran, where the head of Faculty gave me permission for collecting data. As the focus of this research is to look at female students' experiences of mathematics and engineering programmes, I needed access to a university which provided a range of engineering programmes which could be taken by female students (i.e. subjects which were not restricted by the implementation of the 2012 guidelines – see Chapter 1). Jesus university contains both a Mathematics and an Engineering faculty, and I aimed to recruit students from three different courses: non-technical engineering (where the number of women is about the same or outnumbers male students, e.g. computer engineering), technical engineering (where women are in a minority, e.g. EE) and mathematics (where women outnumber male students). I hypothesised that the different gender dynamics on these programmes would in some way affect the FWs that these women narrate in describing their experience of studying mathematics and engineering. Therefore, purposive sampling (Kerr, 2012) was applied to recruit the participants based on pre-assumption principles, like mathematics and engineering male stereotypes (mentioned in section 1.3).

The interviewees were mainly sophomore (first year) students (who entered university in 2013), except one who is in the last year of study (Mona). The initial plan was to recruit students from year two and year three as I felt first year students would have insufficient experience at university, and final year ($4^{th}$ year) students may have a more distant memory of their choice of degree programme. However, I had some difficulty recruiting participants from the Faculty of Mathematics (see below) and have interviewed only two participants here ($2^{nd}$ year and $4^{th}$ year).

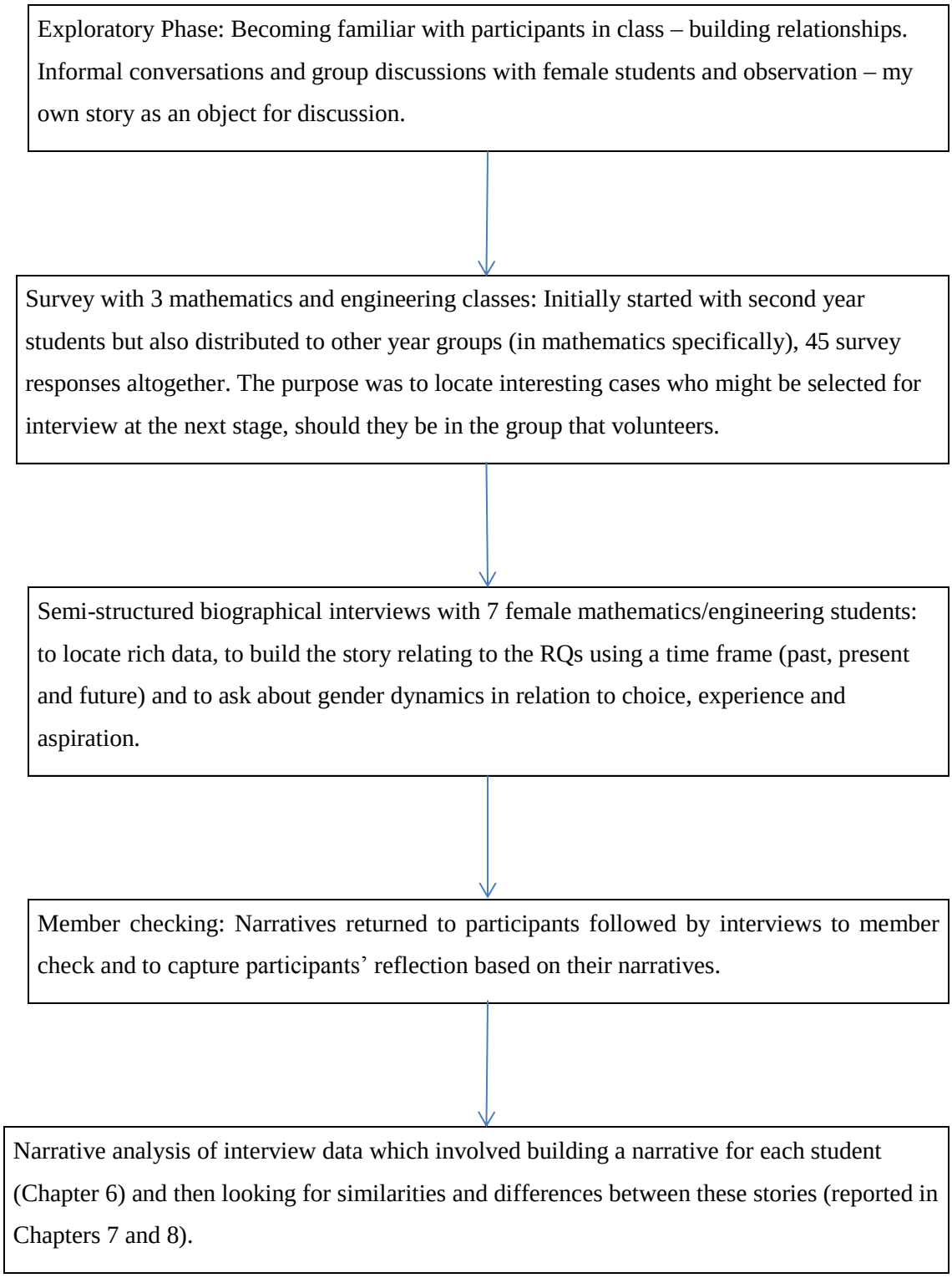
EE at Jesus University was divided into three sub-majors: 1) Electronic engineering, 2) Communication engineering, and 3) Power engineering. Computer engineering was divided into two sub-majors: 1) Software engineering, and 2) Hardware engineering. In addition to the two mathematics students interviewed, I interviewed 5 female engineers consisting of 2 from electronic engineering, 2 from computer hardware engineering and 1 from software engineering.

In 2013, 138 students were accepted into the Electronic and Computer Engineering Faculties at Jesus University, with 50 from electronic engineering and 88 from the non-technical fields of computer software and hardware engineering. 52 students were enrolled in the Faculty of Mathematics. At Jesus University, in 2013, 62% of mathematics students and 55% of computer software engineering students were female. By contrast, women were under-represented in electronic and computer hardware engineering, where participation of women falls to 26% and 44%, respectively. The number of female and male students between 2009 and 2013 across the four programmes is presented in Appendix 4. Given this information, this means that, although there are less mathematics students than planned in my research, the inclusion of computer software engineering students means I still have a group of interviewees who are from degree programmes where women are not underrepresented.

## 5.7 Data Collection

The process of data collection and data analysis in relation to recruiting participants is outlined in the following diagram and each part is discussed more in detail in following sections:

**Figure 3**: The process of data collection and data analysis



### 5.7.1 Exploratory Phase

Prior to the main data collection – I engaged in an exploratory phase, whereby I spent time in the identified classrooms (i.e. Year 2 lectures on the three degree programmes described above) in order to get to know the female students and build 'trust' with them. During this exploratory phase, with the support of lecturers in each Faculty, I attended lectures.

Having given out information about the research in lectures, I also held informal group sessions with female students who attended voluntarily. Here, I offered students my own story as an object for discussion and critical reflection. The subsequent group discussion was beneficial in terms of designing and refining the interview questions. The issues raised in the discussion included the significance of the advisor at secondary school in shaping decisions/choices, the black colour of society (this has a cultural meaning which connects to what is seen as negative or wrong in Iranian society) and the distinction between high school and the conservatory school[7]. As a result, questions were added to the interview schedule for further clarification. The group discussion in the computer and EE classes lasted around 15 minutes and was conducted with 5 female students. In the mathematics class, the group discussion took around 45 minutes and included both male and female students -roughly around 10 female students and 4 male students. The level of interaction between group members was more dynamic in the mathematics class, and many of the male and female students challenged each other's ideas. As an example, one male student mentioned that some engineering programmes are not suitable for women (like mechanical engineering or civil engineering), but a female student criticised this idea and said 'differences depend on the individual and not their gender'. The group discussion was designed to get a feel for what it is like to study engineering/mathematics in this university as a way of contextualising the meanings discussed in interviews at a later stage in the research. When discussing

[7] Conservatory school is the practical high school where students learn courses marginally theoretically and mainly practically. Most often those students of low academic proficiency enter these schools.

my own story as an 'object' for discussion, the students responded with some interesting comments (see Section 1.4 for the summary of the story and Appendix 5 for the whole story). For example, when I asked the group to name my story, they called it black-means-sad and this suddenly reminded me of the colour of black dress they wore[8]. I used this result to continue the discussion which led me to ask about the 'black colour of society' in the interviews (see Appendix 8 for the interview questions).

Through preliminary observations, I also noticed that the three different classes varied in terms of the gender dynamics and followed the structure I had anticipated in choosing these subject areas: 1) in the mathematics class female students were in the majority (22 women and 11 men); 2) the computer engineering class (both software and hardware) had a similar quantity of female and male students (21 men and 20 women), and 3) the electronic engineering class consisted of a minority of female students (25 men and 18 female). There were, however, some other observations which gave me a sense or awareness of the context in which the participants are located. Firstly, I noticed that the students in the mathematics programme did not appear to work together as a group but rather individually. This was somehow different in the engineering faculty, where both computer and EE students worked and talked in groups frequently. There is a space in the basement at the Faculty of Engineering which allows students to work in groups called 'The Lobby'. Students on both EE and computing engineering programmes used the lobby to interact and engage in informal group work. Also, in both the Faculty of Engineering and the Faculty of Mathematics, I observed that the interaction between male and female students was more liberal when compared with my own experience of university. As an example they sat, talked and walked together, which was not the case in my own experience. These two observations encouraged me to query these issues through the interview questions, in order to understand the convergence of viewpoints between myself as the researcher and the interviewees.

[8] Wearing black is common for the Shiite religion which is a dominant colour in Iranian society.

### 5.7.2 The Survey

As mentioned above, during the exploratory phase, I distributed a survey to all female students in each of the classes referred to above in order to collate some brief initial data regarding their degree programme. Whilst initially this was viewed as a tool to recruit potential participants for the interview phase, it also appeared to offer data which validated the interview evidence, and so I have presented a brief account of its findings in Chapter 7.

The survey asked a series of questions in order to find a diverse range of participants who potentially have an interesting story to tell regarding their choice of degree, their experience and their future aspirations. The questions in the survey were designed to focus on choice, experience and future aspirations, and also collate information on students' backgrounds. There was also a question asking each participant to name a movie about their life which was useful as it provided information in a snapshot regarding how the participants might narrate their life stories. The surveys were distributed in class where it was emphasised to the students that completing it was entirely voluntary and choosing not to would produce no consequences. The survey also asked for student contact details in order that I could send follow up emails to recruit potential participants for the interviews. Again, it was emphasised that this process was entirely voluntary. A copy of the survey can be found in Appendix 6.

The survey was initially conducted with second year female students across the three programmes. I gave the numbers in each class above where there male and female mix together. There are 45 survey responses in total: 13 from Electronic Engineering, 6 from Software Engineering, 6 from Hardware Engineering and 20 Mathematics students. Whilst these responses were mainly aimed at recruiting participants, there were some interesting patterns in the responses across the three programmes and I have reported these in Chapter 7. I have done this to try to establish a joint narrative for the group which might help situate the narrative analysis of the individual participant interviews.

The participants' responses in the survey varied across the three cohorts. The Mathematics students showed less interest in collaborating in the research and wrote less in the survey than the other students. In contrast, the Electronic Engineering students were extremely keen to participate. Thus, it appeared that the degree programme where female students are in a slight minority produced more survey data and more interest from the participants (I elaborate on the latter below).

### 5.7.3 Process of Recruiting Participants for Interview

Originally, the intention was to use the survey responses to identify four participants with different perspectives from each of the three degree programmes. This process initially began by looking at how their answers in the survey were compatible with my criteria. These criteria included: a willingness to collaborate with the researcher and discuss issues regarding gender and discrimination in STEM; variations in family background (parental education) and class division (it is important to show the class of the women related to the class structure mentioned in Chapter 2 as this is a prominent issue in capital theory of Bourdieu); and, lastly, evidence of themes relating to agency or world-making or resistance and change of the cultural norms (particularly in the question regarding the film title).

Initially, 12 participants who had completed the survey were approached by email/phone etc and asked to be interviewed. However, not all of those approached responded positively, despite several attempts to contact them, which resulted in only 5 participants being recruited through the survey. There were, however, two other participants whom I approached through sending emails - the email was provided by the students in the faculty (I personally asked them whether they wished to participate or not). In the email, I provided information about the research and I attached the consent form (see Appendix 7 for the information sheet and consent form), again emphasising that participation is entirely voluntarily and there would be no consequence to not participating. In the following section, I outline key information regarding each of the participants in order to a) show how they were recruited and b) give a summary of the information collated about them through the survey. The purpose here is to provide transparent information regarding recruitment and also to explain how initial data collated with each participant suggested they

might have an interesting life story to tell in their subsequent interviews. First, I discuss participants recruited through the survey and then those recruited through the email strategy are detailed. All names provided are pseudonyms in order to protect the anonymity of the participants and I have also changed any place names which might identify the location of the university. I have anonymised any others mentioned in the interviews such as sisters, brothers and parents.

#### 5.7.3.1 The Selection of Second Year Female Students from Survey Responses

Here, I provide an outline of the students who were recruited for the interviews using the survey. I provide details on each participant, since this is important to understanding their narratives which will be presented in the analysis chapters, but also explains why they were recruited as participants in relation to the study's aims.

Zahra was a mathematics student. Her father is self-employed and her mother is a house-wife. She is the last child of the family, with one brother and one sister older than her. Zahra indicated a great interest to participate in this research in both survey and observation. In her survey response, she mentioned that she wanted to achieve the Fields Medal in Mathematics (which had recently been won by an Iranian female, Maryam Mirzakhani). As such, her motive towards studying mathematics appeared quite different from others and she wrote extensively about her love of mathematics. She was also living in a student flat near campus which was relatively unusual, with many female students still living with their families. In the survey, she also gave the name 'figurative mistress' for the movie about her life, since she saw mathematics as a living creature which existed in every moment of her life as someone she feels in love with. Therefore, I felt she might provide an interesting narrative regarding gender dynamics at university as a consequence and, thus, allow me to explore the theoretical concepts identified above.

Sheida was a computer software engineering student. Sheida grew up in a family of four. She has one brother who is older than her and is studying IT. Sheida's parents both graduated from university. Sheida's mother has a master's degree in IT

management but she is not working at the moment. Sheida's father, who possesses a PhD in the field of financial management, is a university lecturer.

Sheida was selected because she appeared to be highly aspirational with a future ambition to be a manager of Google or Apple Company. In her survey response, she wrote about 'patriarchy' as shaping her negative experience at university: "I am faced with a patriarchal system at university", she wrote. She also particularly emphasised her desire to become financially independent (e.g. by being a director of a company). The title of Sheida's life movie was expressed as: The Catcher in the Rye. This draws on J.D. Salinger's book of the same name, where a young man tries to escape from difficulties and in the end reaches a point of ambiguity which means he still cannot choose his own life path. For this reason, I felt that Sheida might provide an interesting narrative to study concepts of agency as outlined in my theoretical framework (Chapter 4).

The third participant, Yalda, was a computer hardware engineering student. Her father studied political science at university and her mother is educated to secondary school diploma level, and is now a house wife. She has three older brothers and she is the only daughter in the family. Yalda was active in both the group discussion in the exploratory phase and wrote a lengthy response in the survey. Her survey response indicated a desire to change the world around her such as changing the exam system at university and altering people's views toward women working in engineering. The title of Yalda's life movie was written as 'Try a Different Future'. She expressed that she wished women to be successful in her subject area and did not like people who consider women to be of lower ability in engineering fields. Therefore, I felt that she might provide an interesting narrative in terms of how she came to such beliefs/aspirations.

Maryam was an electronic engineering student and was approached for several reasons. The first is that her mother's level of qualification attained and career status was reported to be higher than her fathers in the survey. Her mother possesses an MSc in law and she had retired from teaching. Her father holds a diploma certificate and he is self-employed. This was unusual in Iran (at the time of their marriage) and, therefore, I assumed that her view on marriage and traditional values might be

different from the others, and thus would allow me to investigate ideas around agency, cultural models and identity. It is worth mentioning that she is the only child in the family. The second reason is that, despite her interest in courses such as art, basic sciences and humanities, she reported she had opted for EEin order to pursue her dreams, namely living abroad and studying electrical or medical engineering at postgraduate level. Therefore, I felt that her narrative might offer insight into the status of engineering degree programmes both in Iran and globally, allowing me to study them as a form of capital. The name of the movie she chose regarding her life was "confusion", which she connected to the fact that she could not centralise her interest towards one subject. Therefore, I selected her as a possible interviewee because I felt she would provide an interesting perspective on choice of degree.

Hiva was also an electronic engineering student and reported that she particularly enjoyed living away from her family whilst at university. Hiva is the third and last daughter of her family. Her father, who possesses master's degree in aerospace mechanical engineering, has worked as a senior engineer. Her mother is a house-wife but is suffering from ill health due to diabetes. Her sister, who is the oldest, is married with one child and is waiting for her citizenship to live in Canada. Her older brother is a PhD student studying abroad. She reported preferring to work in a group environment where girls and boys are mixed together and had originally wished to study art and then work in the theatre, but her parents had not allowed her to do this. Hiva also reported lots of goals in life such as learning dance, learning scuba diving, helping orphans, and buying a house and changing it into a small factory to build things. In answering the third question (future aspiration), in the survey she also wrote that 'every person is surrounded with thousands of dreams but I believe that I am one of the most ambitious ones'. The title of her life movie was "May never be found', which she appeared to connect to future relationships and finding love: "indeed I do not know what is or who is that I can be completely in love with?" she wrote. Hiva was extremely keen to collaborate with the researcher; she wrote a lot in the survey and shared many personal issues with the researcher individually throughout the research process. Thus, by selecting Hiva as a possible interviewee, I felt I would access better quality data due to the good relationship between us.

#### 5.7.3.2 The Selection/Recruitment of Female Students by Email

As can be seen above, Zahra, Sheida, Yalda, Maram and Hiva are those students who have been chosen purposefully from their survey responses according to my criteria. These students showed interest in participating in the research and also reported beliefs/comments in the survey which suggested their stories might be useful to explore the theoretical concepts I have identified. However, since I felt that 5 participants was insufficient to capture the breadth of narratives I wished to obtain, I approached other students from outside of the classes I originally accessed. There were two other interviewees in total (1 mathematics student and 1 computer hardware engineering). These recruited participants were mainly reached by email through snowball sampling techniques (e.g. I asked Hiva to give other possible respondents' email) but I also sent a recruitment email to other cohorts on the relevant degree programmes in order to broaden the scope of the sample originally identified (Kerr, 2012). To this end, 2 students responded stating they were interested in participation. Although my criteria were not involved in selecting these two remaining participants (since at this point it was urgent to recruit participants to ensure there was sufficient data), they still presented stories which allowed me to address my RQs regarding choice, experience and future aspirations. 2 of these email respondents subsequently completed the survey so that I had an overview of their experience and aspirations, and their responses are summarised in following the paragraph. These two interview participants were:

Sarah, a computer hardware engineering student, came from a religious family. Her father is a priest/Mollah and she lives in a holy place in Iran. Sarah's mother is uneducated and is a house-wife. Sarah reported that she wished to become an academic at Stanford University. When asked to write the title of a movie about her life, she wrote “a normal person”, since she wanted to be special but to live like an ordinary human. In sum, I felt that her religious background and her aspiration towards living and working abroad might make her an interesting interviewee.

Mona was a senior student studying mathematics. Her father is a school principal and her mother is a housewife. She has one brother who is a PhD student in mathematics. She had chosen to study mathematics because she had always liked the

subject and wanted to be a Mathematics lecturer in the future. In response to the question regarding the name of a movie about her life, she wrote "I am only a student". She believes that, many times, lecturers, university administrators and students forget about this fact. She stated that lecturers are not supportive and they have high expectations of students. Despite her dissatisfaction towards university, she reported that she was still fond of mathematics. Hence, I felt her interview might be interesting because of the sense of conflict between her perceived expectations placed on her and her resistance and persistence with studying mathematics.

In total, there were 7 participants who were interviewed and, although I was not able to select all of them as potentially 'interesting cases', those that were recruited in the later phases of the research still appeared to provide interesting comments to the survey or myself, which suggested their narratives might be useful to explore. That is, they made comments which suggested they might report views/experiences which could be unpacked using the theoretical framework, and they also suggested a diverse range of past experiences, family status, geographical location and aspirations. Before presenting the analysis, I will now explain the process of conducting the interviews and how this data were analysed.

### 5.7.4 Interviews

#### 5.7.4.1 Design of Interview Questions

To design the interview questions, a combination of both biographical questions and semi-structured questions were used. Biographical questions were applied in order to identify how the women narrate their life story in relation to their choices of mathematics/engineering (e.g. 'Tell me the story of how you came to be a student on this course'). This helped to enact the narrative inquiry methodology which I outlined earlier, since it asked participants to express their choices and experiences in narrative form, thereby provoking them to construct their sense of reality in a particular way (Bruner, 1996). However, there were also some core themes which I wished to discuss with the students, since I felt them potentially important for understanding the participants' choice and experience of studying mathematics and

engineering, such as traditional values, gender stereotypes, the influence of family and friends, etc. Therefore, semi-structured questions were used later in the interview in order to probe some topics which were potentially important but had not been raised by the participants in their initial story. This is supported by Wengraf (2004), who states that semi-structured questions allow the interviewer to go in-depth slowly by asking the interviewee to orient themselves to the concepts and questions that are important to the researcher.

I also asked the participants about some of my pre-assumptions, for instance, whether the mathematics -male stereotype is evident on their degree programme and/or whether it is perceived as dominant in Iranian culture. In general, the interview questions also went beyond the primary questions (choice, experience, aspiration and gender) and the participants were asked about their survey responses, the group discussion, my pre-assumptions and observations. An overall list of interview questions is presented in Appendix 8.

To increase the credibility of the interview questions, the participants were asked to point out if they were confused by any of the questions or had difficulty in interpreting what was meant. All of the participants seemed comfortable answering most of the questions, however they had difficulty replying to the question: 'Can you think of a young woman who was not able to enter into university? Why did you choose her?' This question was initially included to provoke participants into discussing potential barriers for women accessing university. However, this did not seem to make sense to them, possibly because, as fairly affluent female students already attending university, they had not encountered such individuals. The participants believed that all female students could enter to university due to the fact that there are many private or distance higher educations in Iran. Therefore, I removed this question from the schedule after interviewing some of the participants.

#### 5.7.4.2 Conducting the Interviews

Wengraf (2006) describes how to conduct biographical narrative interviews, where the purpose is to give the participants the chance to tell their own story in their own words without too many prompts or guidance form the interviewer. The method of

narrative interviewing is one which involves "... a relatively coherent ‘whole story’ or ‘long narration’ with a relatively large number of recalled ‘particular incident narratives’" (Wengraf, 2006, p.6). However, Wengraf suggests that we can use this method either directly (full length narratives - ‘life story’) or in a modified version which combine both biographical and semi structured questions. As detailed above, this research adopted the modified version in that I used some broad questions (biographical questions) first, followed by semi-structured questions. I conducted the interviews fairly methodically to ensure I had understood specific words and their meaning, and I then tried to use such words/meanings in later questions (semi-structured questions). The interview was conducted in Persian. Some specific interview questions were not asked if the participants had addressed them earlier. Throughout asking the broad questions, I gave the interviewee the chance to talk as much as they wanted, without any interruption. However, when any important topics or any unclear issues emerged during their initial talking, I asked them as soon as they finished their dialogues.

In order to understand and evaluate my method of interviewing, I kept listening to my voice. Listening to my voice enabled me to evaluate whether I was implicitly communicating any judgment regarding participants’ responses or interrupting their conversation. I tried to remain calm during the interviews, not to use body language too much, and show the participants my interest in what they were saying.

During the interview session I also attempted to build a relationship with the participants in order to provide a comfortable atmosphere for our meeting. Talking informally before the interview, giving time to think about interview questions and sharing my ideas when similar experiences emerged during the interview were some techniques I used for developing my relationship with the participants. For instance, my role as an interviewer played a significant part in Zahra’s interview, as was the case with the other participants. My role as an insider helped to understand the dominant culture and consequently caused for asking more questions. For example, the role of me as an insider is visible in the dialogue in Section 6.5.3 (Chapter 6), where Zahra discusses receiving divination from Hafez poetry (see Apendix 10 for the full interview). The question I asked, “Are you serious?”, indicates that I am pretty amazed at this story; she impresses me and so she states the outcome of this

story very definitely “I didn't choose any other subjects”. Therefore, I suggest my role allows me to interpret the meaning of the cultural models and figures outlined in her story.

Each participant was interviewed for about one hour, except one (Hiva) who was interviewed twice because we were not able to discuss all the topics in one interview. None of the interviewees were alike, and this shows how each individual is different in terms of illustrating different attitudes and understanding the surrounding.

#### 5.7.4.3 Member Checking

I had planned to undertake a second round of reflective interviews, whereby each participant’s narrative was discussed with them as an ‘object’ of discussion. However, this was not possible as only two participants agreed to be interviewed again and reflect back on their stories (Zahra and Yalda). However, a second aim for this process was to offer the participants the opportunity to member check the data in order to ensure they were fully aware of the data they had provided and were happy for this to be incorporated in this thesis. Whilst only two students accepted this offer, it is important that the offer was made so that all participants had the opportunity to object to how their data is used. None did. To clarify, I continued to try to set up member checking interviews throughout the field work period but such requests were not responded to (note all participants gave written informed consent and ongoing consent checking was used throughout the interviews).

Furthermore, the constructed stories which were to be the ‘object’ of such discussions supported the development of the narrative analysis framework since they were based on past, present and future (see Zahra’s short story in section 6.2 for the sample).

## 5.8 Method of Analysing Data

### 5.8.1 Analysing Survey Data

In Chapter 7 I have presented briefly some of the survey data since it provides some useful general data regarding students' beliefs, choices and aspirations which act as a back-drop to the individual narratives provided in the interview data. Note that this survey data was initially used to select participants, but upon reflection it also appeared useful in detailing the prevalence of certain beliefs, cultural models, etc. amongst students at Jesus University. The process of analysing the survey data is listed in Table 8 in Chapter 7, which focuses mainly on future career choices and qualifications amongst the student cohorts. The survey data was analysed using a thematic analysis, where participants' written responses were separated into particular themes regarding choice of degree, aspirations, etc. Therefore, the survey provided a broad view regarding gender and participation in STEM and I have used descriptive statistics to report the themes which emerged from the data.

### 5.8.2 Narrative Analysis of Interview Data

For analysing the narrative interview data, the study adopted an iterative approach where interviews with participants were read for significant events/information, which were then constructed into narratives. According to Agar and Hobbs (1982) validity in narrative analysis relates to the coherence and structure of the narrative in terms of how it is situated both locally and globally. This means that interpretation should be derived from the ordering and construction of the text into a coherent story which fits both with the interpretation of the narrator and with the dominant themes derived from the theoretical framework. The former can be established through the researcher's reflexivity with whom the participant co-constructed the narrative in the interview. In this sense, I used the mirroring question and answer technique and paid attention to how the interviews developed. According to Myers and Newman (2007), mirroring is a method in which the interviewer takes the words or phrases used by

interviewees and repeats them in a subsequent question or comment in order to minimise false interpretation or differences in the conceptualisation of the words/phrases used in the study. I used some broad interview questions initially and then increased the level of detail, so that I was able to understand some specific words participants used which I then used in further questions.

The process of analysing the interview data using narrative analysis was initially tested out using Pari's case in the pilot study and then adopted for analysing the interviews with my participants in the main study. I then analysed these narratives thematically using the conceptual framework outlined in Chapter 4 (cultural models, FWs, world-making, etc.) in order to look for similarities and differences amongst the stories and to explore the extent to which the women are positioned by the dominant beliefs outlined earlier or whether they have agency in resisting or transforming such beliefs. In this respect, I looked for conceptual themes which emerged through reading the narratives. Note that these themes were analytical concepts (e.g. cultural capital) and therefore are manifest in the data in different ways. For instance, one student may align with the belief that engineering offers capital or status within the field of Higher Education, whereas another might resist this kind of belief and reject their right to acquire or exchange such capital. By constructing narratives of each individual interview, I was then able to see particular themes across the data and consider the extent to which they say something about the FWs that my participants share. Note, here, that these FWs might relate to the specific course they are on, or being a female student in an Iranian university more generally. Not all participants shared all of the FW identified, but there were sufficient similarities across the narratives to suggest some were shared.

In the next chapter, I present Zahra's narrative as a chapter on its own, as her story focuses on how she self-authors her unique mathematics identity in a narrative of 'success against the odds' (Solomon, et al., 2016). Her love of mathematics and the difficulties she perceived she might encounter in becoming a successful mathematician made her story different from the other participants. She was the only mathematics student who showed an interest to be interviewed by me and she was really keen that her voice was heard by others.

However, how I shape her story is also important. Here, I have used her ideals to build up evidence of Iranian cultural models in order to show the distinction between Iranian CMs and those which might be visible in western literature on women's access to STEM. Therefore, to the best of my knowledge, I attempted to form her position in this story. It is worth mentioning that, although it is Zahra who narrates her story, I argue that I am able to interpret her meanings because I am a partial insider who was there in the moment.

I have presented her narrative on its own because it enables me to model the application of the analytical/theoretical framework, but also because it illuminates some of the normative beliefs/CMs presented in the narratives of the other women who appear in Chapters 7 and 8.

### 5.8.3 Piloting the analytical framework

As mentioned above, I conducted a pilot analysis using a transcript of two interviews with a British Asian Mathematics undergraduate student, Pari. The purpose of this was to trial the conceptual framework outlined in Chapter 4 as a means to analyse the subjective experiences of female STEM students and to see if this could be done using narrative analysis. The interview transcripts were accessed from a dataset from the TransMaths project (www.transmathematics .org.uk), which also looked at student aspirations when studying mathematically-demanding programmes at university. My narrative analysis and reflections on the framework can be found in Appendix 9. The pilot study helped me in various ways since it gave me experience of constructing a narrative from the themes and the dialogue in the transcript, and then it allowed me to evaluate the conceptual frame work (FW) as it might be applied to the data.

This pilot analysis suggested that the use of concepts such as cultural models, figures and agency are important in analysing how individual students make choices regarding STEM degree programmes (and especially in difficult circumstances in Iran (in gender terms mentioned in Chapter 2). In Pari's case, it was possible to see how her choice of mathematics and her experience at university (e.g. she feels

‘weird’ and ‘shy’ about the boys at university but she attempts to leave this feeling behind as she wants to adopt her selves with new environment) blended together to allow her the opportunity to imagine herself as a role model to other British Asian women in similar circumstances. Drawing my attention to this story as an example of world-making allowed me to understand how FW can be shaped and transformed into new FWs. Therefore, in my main study I have used this to explore whether the women I interviewed described a FW in relation to studying mathematics/engineering, which created space for them to either maintain traditional values (e.g. enhancing marriageability) or to challenge such traditional values (agency/ improvisation and making a new world). This led me to focus on the concept of agency and how this might manifest itself in the women’s narratives differently.

Additionally, understanding 'troubles' also appeared important in my pilot analysis, since it allows me to consider any difficulties faced that have changed their opinion and/or trajectory towards studying mathematics/engineering and further towards participating in the labor market. However, in my analysis of Pari’s story, whilst I expected troubles to be important, this did not seem to be so, or rather 'troubles' as a concept did not seem to be an explicit part of herself authoring. So, whilst Pari spoke of some troubles (e.g. financial hardship, health problems), they did not seem to resource her in 'becoming a teacher' or relate to the figures and cultural models which she did say were influential. Nevertheless, there were troubles which were more implicitly embedded in the cultural models she resourced with (e.g. bad teaching, cultural barriers for British Asian females). So, to identify troubles in my participants' narratives may require sensitivity to or questioning of beliefs and cultural models which are implicitly shared in our culture (more obvious in Zahra’s story). The task is to make these shared beliefs explicit in the interviews. This is a challenge for me as a researcher - to be fully reflexive and to be aware of what I take for granted and to question it.

## 5.9 Transcription and Translation

With the exception of Zahra's interview, I transcribed and translated only the parts of each interview that I wished to use in formulating the participants' narratives. In the first instance, I transcribed and translated the whole of Zahra's interview as I wanted to test out the application of the theoretical/analytical framework to see how it much information was needed to construct the narrative. The task of transcribing and translating was demanding, however, and I quickly realised that it was not necessary to transcribe the whole interview, just the parts needed to present the story.

For the remaining participants, I listened to the audio recording (in Persian) of each interview extensively and then transcribed particular comments which related to the theoretical framework or were significant to the themes established previously. I transcribed the interview data in Persian initially and then translated comments into English (the comments presented in subsequent chapters appear in English). I did not encounter any particular difficulties in translating the data and there were few Iranian cultural terms which were not easy to translate for a western reader. My positionality in the research was helpful in this respect, since I have lived in the UK for a considerable amount of time and I was born and grew up in Iran. This experience means that I am familiar with western values/assumptions/stereotypes but I am also familiar with Iranian norms too, and thus I could broker between the two cultures in terms of translating intended meaning in the data. Therefore, to the best of my knowledge, I have provided an accurate translation of the interview data, drawing on my insider cultural knowledge and my knowledge as an outsider (now living abroad). In addition, my presence as interviewer during the interview enabled me to access intended meanings and contextual information which helped me during the translation process and analysis. However, I did counter-check my translations with a colleague (English Lecturer) during the fieldwork state – this individual is someone who is known to me professionally but not to Jesus University where the research was conducted. This colleague confirmed my translations were more or less accurate representations of the Persian interview data.

## 5.10 Ethical Issues

As this research focused on a potentially sensitive topic (i.e. gender relations in Iran), ethical issues needed to be fully considered throughout the data collection and analysis process. The participants needed to feel safe to 'voice' their perceptions and be guaranteed that the research was conducted in a way that ensured their anonymity, confidentiality, conformity with data protective laws, and that all data collected was kept securely. I followed the ethical guidelines and research integrity procedures of the SEED Research Integrity Committee at the University of Manchester and the British Educational Research Association. I provided participants with an information sheet and consent form which was translated into Persian, and was given to each participant along with a copy of the interview questions in Persian two weeks before the interview.

Furthermore, effort was made to construct interview questions in an ethical manner (i.e. by avoiding questions which might be seen to address politics in Iran or other controversial topics). The interview questions focused on participants' attitudes towards studying mathematics and engineering, and their perceptions of how gender might influence such attitudes, beliefs, etc. This was to avoid coercing the women to discuss potentially controversial topics. However, on a number of occasions some participants did make political statements or reveal their experience of activities which might be considered as controversial in Iran (for instance, Hiva spoke of her underground theatre work). In such cases, I used ongoing consent to check that the women were happy to proceed with the discussion. Having said, for ethical reasons, there are some aspects of the interview data that I have omitted from the analysis in order to be cautious regarding potential consequences for the participants. Here, I have used common sense but also I emphasise that pseudonyms have been used at all times including place names, city and the name of Jesus University.

Furthermore, during the interviews it was also important to ensure that the discussion did not cause distress or upset for the participants. In the Iranian context, asking questions about personal matters may not be appropriate and so I avoided this where

possible. However, it was still possible for participants to discuss topics such as religion, the opposite gender and social prestige, should they bring them up. Here, I also argue that trust and friendship was very important between the interviewer and interviewee, and this can be achieved through sharing similar beliefs and values. The presentation of my story to the women helped here as it highlighted the kind of narratives I was looking for and indicated that I shared many of the experiences the women encountered.

The women also had the right not to answer any personal or perceived-as-inappropriate questions. Furthermore, participants were asked for authorisation to record their voices in the interview.

## 5.11 Conclusion

In this chapter, I have outlined the methodology I have adopted in this thesis to explain how I designed the research and went about gathering and analysing qualitative data in order to collate evidence of female students' perceptions of being a mathematics or engineering student in the Iranian context. In doing so, I have explained the different methods used in order to collect data and to build trust with the participants during my field work study.

In the next part of this thesis, I move on to discuss the research analysis which seeks to explain the finding of the research in relationship to women's access to mathematics and engineering in HE, in order to establish: i) how do the cultural-historical-economic structures and conditions of Iran manifest in Iranian female STEM students' narratives regarding their choices, experiences and aspirations? And ii) how do Iranian female STEM students position themselves in relation to such contextual conditions? Therefore, the concepts which are useful in understanding these questions will be operationalised in order to illustrate the findings of my analysis and explain how investigating this topic in the Iranian context might add to current understandings of gender and STEM participation.

# Chapter 6: The Case of Zahra: A 'success against the odds' Narrative

## 6.1 Introduction

This chapter presents a narrative analysis of one of the participants in the study, Zahra, using the theoretical framework outlined in Chapter 4. The purpose here is to:

Firstly, exemplify the analytical approach taken in order for the reader to understand the narrative work which underpins the identification of themes across the narratives which are presented in Chapters 7 and 8. Secondly, to explicitly operationalise narrative concepts from the theoretical framework (such as identity, cultural models, FW, self-authoring) in order to address RQ1 and RQ2:

RQ1: How are cultural-historical-economic structures and conditions of Iran manifest in Iranian female STEM students' narratives regarding their choices, experiences and aspirations?

RQ2: How do Iranian female STEM students position themselves in relation to such contextual conditions?

In Chapter 4, I outlined the theoretical framework used to analyse the data in this thesis, and in this chapter I focus specifically on the concepts draw from Holland et al., (1998) in order focus on Zahra's self-authoring of her mathematical identity. Table 7 below outlines how I have operationalised these concepts. I argue that, by doing so, I can highlight how cultural practices from within Iranian society and from the global mathematics community mediate her constructed, narrative self and thereby shape her perceptions regarding choosing mathematics and aspiring to become a mathematician. This chapter therefore serves as a precursor to Chapters 7 and 8 which focus more on Bourdieu's concepts, particularly capital.

**Table 7:** Definition used to read the concepts

| **Concepts** | **Definition of concepts (drawing on Chapter 4)** | **Concepts in Use** |
|---|---|---|
| Figured world | Figured world is a "socially and culturally constructed realm of interpretation in which particular characters and actors are recognized, significance is assigned to certain acts, and particular outcomes are valued over others" (Holland et al., 1998, p.52). FW are the social spaces we operate and practice in which contain values, beliefs and ideas about what is right and wrong, etc… (i.e. cultural models). They also contain figures which we use to identify with or against. People in FW usually are the figures in the story, e.g. the role-model, the anti-hero and the symbolic figures. The figures and cultural models in this study are part of the figured world of being a mathematics/engineering student historically (at school), present (at university) and in an imagined future (as a successful woman). | When Zahra points out that she is studying in classes 'ahead of her level' and 'I was so good at that course that I could answer many of the questions' she discusses her unique mathematics identity in the FW of mathematics class at university. Thus, she sees herself as a clever student who acts differently from other students. For example, she points that out that 'others cannot stand me' which 'may result from their jealousy'. |
| Figured Worlds: Cultural models | Cultural models are socially shared beliefs/values which inform our actions/behaviours. They appear in individual narratives but are also distributed across time and space (sometimes within local groups, e.g. amongst students on a mathematics/engineering programme) and sometimes across wider societies (Bruner, 1986). "Cultural models are stereotypical distillates, generalisation from past experience that people make"(Holland et al, 1998, p.55). Cultural models will be analysed with emphasis on symbolic terms, beliefs and values which are rooted in society and family background. For example, in this context beliefs such as 'mathematics having less status' and 'mathematics students seen as engineer failure' will be explored as the kind of social beliefs about mathematics. So, there is a little story here about the belief of mathematics which is culturally specific. | "I knew that mathematics doesn't need good grade to compare with engineering, thus I didn't study that much and I knew I would be accepted in mathematics anyway" said Zahra.<br>In this quote, Zahra compares the grades required for mathematics to those required for engineering – she narrates her past experience in relation to the status or exchange value these subjects have, with mathematics being lower status and not requiring high grades. |

| | | |
|---|---|---|
| Identity | “People tell others who they are, but even more important, they tell themselves and then try to act as though they are who they say they are” (Holland et al., 1998, p.3). These self-understandings, especially those with strong emotional resonance for the teller, are what Holland et al. (1998) refer to as identities. Gee (2001, p.99) sees identity as a “kind of person in a given context” and, since we encounter many contexts in our daily lives, we can say that we adopt multiple identities. This interpretation of identity (ies) aligns with Holland et al. (1998) who view identity as emerging from the heart of culture. According to Hallowell (1955a) “individuals live in worlds that are culturally defined and understand themselves in relation to these worlds” (Holland et al, 1998, p.54). The concept of identity from this point of view relates to an individual who knows themselves from the particular cultural practices they participate in and then acts accordingly with what we might call ‘identities in practice’. I argue that the interview context provides a space for a special kind of identity in practice where we reflect on who we are and story ourselves in a way that brings these multiple identities together or into conflict. | Zahra displays the construction of a mathematical identity based on difference and being special. Her use of ‘I statements’ reflects the attribution of mathematics as elite to herself: "When I was at first year in high school, Mrs X was our mathematics teacher. First time she came to our class, she didn't teach us and she only asked about some of the main concepts in mathematics and it was only me who answered. She asked me about my background in mathematics and I told her that I have been working a lot in mathematics and I like mathematics ".<br>The use of the personal pronoun is prominent as in ‘I like mathematics ’, ‘I worked a lot in mathematics ’, and ‘I love mathematics’. |

| | | |
|---|---|---|
| Identity: Positional identity | Positional identity relates to "behaviour as indexical of claims to social relationships with others. They have to do with how one identifies one's position relative to others, mediated through the ways one feels comfortable or constrained, for example, to speak to another, to command another, or to enter into the space of another" (Holland et al., 1998, p.127). In other words, positional identity is an identity which builds up through having relationships with others to see your position in comparison with other positions. | In one instance, Zahra positions herself as exceptional when she compares herself with other students in the class: "I was ahead of my classmates in doing mathematical equations in my classes, I always solved mathematical equations but others did not". In another place, in describing the FW of her university classroom she spoke to the lecturer in order to make peace in the class (there had been some disruption). Here, she constructs herself as a diplomatic person who tries to keep calm when others get angry with her or each other. She is aligning with the lecturer by taking responsibility for the smooth running of the class. |
| Identity: Figurative identity | "Figurative, according to Webster's Third International Dictionary, means transferred in sense from literal or plain to abstract or hypothetical; representing or represented by a figure" (Holland et al., p.53). "Narrativised or figurative identities have to do with the stories, acts, and characters that make the world a cultural world" (Holland et al., p.127). Figurative identity is an abstract identity which shapes the activity of an individual in an abstract world or cultural world. | In Zahra's story the figure of Pythagoras, Cantor and Grothendieck can be seen as figurative identities as they are guiding her pathway of becoming a successful mathematician: "I proved that Pythagoras theory, with all of its 380 evidences, was wrong". She also mentioned that: "Other students also called me Pythagoras, making me sure that mathematics is my ultimate choice". |

| | | |
|---|---|---|
| Identity:Designated identity | According to Sfard and Prusak (2005, p. 18) "designated identity, consisting of narratives presenting a state of affairs which, for one reason or another, is expected to be the case, if not now then in the future". So designated identity is an identity of future self that one is becoming. | Zahra self-authors a designated identity of becoming 'the best' through her plan to achieve the Fields Medal for mathematics: "I would like to take a part in mathematics competitions and for example to achieve some medals, nationally and internationally". |
| Identity: 2nd person identity | 2nd person identity refer to identities told by others to a person. In this sense, 2nd person identity is constructed through the judgement of others and is to do with the alignment of individuals to position themselves according to other people's judgment (Sfard et al., 2005). In other words, 2nd person identity is internalised with what others assign to individuals. | An exceptional identity was assigned to Zahra by her teacher: "the teachers always told me that you are better than others in terms of mathematical ability" she said. |

| | | |
|---|---|---|
| Troubles/ Conflict in story | "Stories worth telling and worth constructing are typically born in trouble" (Bruner, 1996, p.142). Identifying these troubles is important because they may be "very sensitive to changing norms" or the trajectory of the story and further they can be critical events in the story - changing students' trajectory towards studying mathematics. | In this analysis, I adhere to what Bruner calls 'the centrality of trouble' and this can include any problems that Zahra faces in self-authoring her identity as a mathematics learner. In this respect Zahra speaks of not being accepted to study mathematics at the best university in Iran, and she states she was bullied by her family because of this incident. She also describes being bullied by her peer group at university because of the comments she gave in the classes. She uses troubles as a narrative device in self-authoring her mathematics identity, positioning herself as 'special' which resources her tale of 'success against odd': "I remember last term I participated in a class named Mathematics Analysis which was ahead of my level. I was so good at that course that I could answer many of the questions. This capability of mine was so annoying to the classmates that they sent posts on the Facebook to prevent me from any comments 'those who do not belong to this class stop remarking". |

Before moving on to analyse Zahra's data, I present a summary in order to highlight the narrative I have constructed using her interview.

## 6.2 Summary of Zahra's Interview

Zahra has chosen to study mathematics and, at the time of interview, she was in her second year. She lives in a student flat near to Jesus University as her family home is some distance away. She reports that she found out in primary school (grade five) that she was good at mathematics. Her teachers realised that she was different in terms of mathematical ability and they encouraged her to do more work. Zahra's relationships with her teachers before university mainly influenced her decision to study mathematics but her parents and families were not pleased, mainly because of the lower status associated with mathematics compared to other STEM subjects (e.g. engineering).

Zahra's perception of other students (and some academic staff) at university is rather negative as she believes they do not really care about mathematics. She reports that she wanted to be active in the class but this was contrary to other learners' satisfaction as they did not appreciate her engagement. Whilst she makes negative points about her experience of teaching and learning at university, these comments have not changed her positive view towards studying mathematics.

In the future, Zahra wants to achieve the Fields Medal in mathematics, so her aspirations are a little different from others in the class since none of those who completed the survey indicated such aspirations in relation to mathematics (see Chapter 7). She considers herself to be an aspirational person as 'Many times my goals would become like a dream'. Zahra said this sentence to indicate the scale of her ambition. However, she does not intend to live outside of Iran in the future, which is often the case for those who are highly aspirational (see Chapter 8). She emphasises that if she moves out of Iran in order to continue studying mathematics, she will come back to Iran as she does not wish to live far away from her family. Thus, her moving away from Iran would be temporary.

Zahra believes that there is a difference between being a mathematician and achieving a high level of status in society and being famous. She added that people normally mix them up together but she herself declares that she likes mathematics only because of the nature of the subject. In this respect, Zahra expresses a motive to

fulfil inner desires (love, passion and motive) and she speaks of 'feeling the beauty of mathematics' and 'internal enthusiasm' in this respect.

Finally, when asked about gender, Zahra considers mathematics to be a male subject due to the fact that ‘many mathematicians are men’. However, this is not a story without conflict since she does recognise that ‘women achieve higher scores in mathematics, and ‘having Mirzakhani as a great female mathematician in the world’ indicates that it is possible to be a successful mathematician and female. But despite such comments, Zahra does not change her overall position on gender and mathematics, and by the end of the interview she insists that mathematics is a masculine subject.

## 6.3 What is/are Zahra's Mathematical Identity(ies)?

Zahra's choice of mathematics for her undergraduate degree is expressed as an intrinsic love of mathematics – a motive which she sees as 'authentic' or genuine (implying that others are less genuine in their love of mathematics). She frames her love of mathematics as a gift suggesting it is something that is inside her – an intrinsic talent: ‘the pleasure that I get while I am solving mathematics equations and I have mathematics ability too’ (see Section 6.3.2 for full quote). She compares her own desire towards mathematics with others who do not genuinely love the subject, and states that this passion informed her choice to study mathematics:

> *I see people who are very successful in mathematics but didn’t come to mathematics only because they love mathematics. They like to be a mathematician; do you know what I mean? I don’t like that.*

My analysis of Zahra's story has generated some themes which directly relate to this conceptualisation of 'inner desire' such as pursuing hobbies in mathematics, her aesthetic sense of mathematics, and her authentic love of mathematics. She uses these to self-author her identity as a certain kind of mathematical person, as outlined below.

### 6.3.1 Taste of Hobbies in Mathematics

In self-authoring an account of how she developed her mathematics identity, Zahra constructs her authentic interest in mathematics using evidence such as her hobby of reading mathematician's biographies and painting pictures of mathematicians. Her references to such hobbies, which are not compulsory, are used to show how she feels compelled or even driven to mathematics by some internal factor (interest) rather than an external stimulus (e.g. to get good grades). She constructs an inner desire to pursue mathematics drawing on her past experience. She says that:

> *All the time I was reading the story of mathematicians. I remember I was painting and the only thing I could paint was the picture of mathematician. I couldn't draw anything else. I can recall that all the time I was interested in activities like this.*

Here, the phrase 'I couldn't draw anything else' indicates the strength of her inner desire for all things mathematical - it is not something she is in control of, but driven to do. In so far as this inner desire is located as being internal or inside of herself and is constructed as consistent across time ('all the time'), we can argue that Zahra reflects on her disposition to pursue mathematics as fixed and innate.

### 6.3.2 Aesthetic Sense in Mathematics

Zahra also states that her love of mathematics stems from the pleasure of solving mathematics equations and her 'mathematics ability'. In fact, the nature of mathematics itself as 'beautiful' appears to be crucial in fostering her internally located desire or need to do mathematics. In the quote below, Zahra states 'maybe it's because I feel the beauty of mathematics', suggesting that others might become like her if they understood the world in the same way she does (like me). Therefore, she constructs a FW of 'those who do mathematics' where different members might hold different positions according to whether they are able and whether they 'feel' the beauty of mathematics. The aesthetic sense of mathematics is a cultural model as it is socially shared among its members:

*N: What was in mathematics that made you loving mathematics so much?*
*Z: I should say that Love has no explanation. I don't know exactly but I think the main reason is the pleasure that I am getting while I am solving mathematics equations and I have mathematics ability too. If I enjoyed mathematics but I didn't have mathematics ability I wouldn't love mathematics that much. Maybe it's because I feel the beauty of mathematics. If anyone understood the beauty of mathematics like me, they would perhaps enjoy mathematics.*

Once again we see here a belief that her mathematics identity is innate and fixed: 'love has no explanation' which suggests she can identify no external cause for her intrinsic enjoyment and 'I have mathematics ability too' also suggests there is something inside of her which mediates her 'love of mathematics'. In addition, by emphasising the aesthetic beauty of mathematics, she identifies with a specific cultural model which she perceives to be exclusive (not everybody 'feels' the beauty of mathematics) - that mathematics is creative and beautiful rather than simply about getting right or wrong answers.

### 6.3.3 Authentic Love of Mathematics

As noted above, Zahra describes this love as signalling an authentic relationship with mathematics which 'others' mathematicians might do but for her is about genuinely loving the subject:

*N: Do you like to be someone who like mathematics but don't want to be known?*
*Z: No, I don't want to be unknown. I like fame as well, but because of the mathematics I like fame. However, people are normally opposite of this, they say that they like mathematics but because of the fame they like mathematics. They have talent as well, they are progressing, but they don't love mathematics. There are many mathematicians who do not love mathematics but followed mathematics just for being famous.*

Therefore, in self-authoring her mathematics identity, Zahra uses her love of mathematics as a means to position her identity as different from others ('people are normally opposite of this') and special because she does not conform to normative beliefs/values by prioritising what she loves ahead of fame and social status. In her FW of being a mathematician, Zahra recognises that there are different kinds of

relationships with the subject but she positions herself as having a more legitimate status because of her 'inner love'.

## 6.4 Positional Identity in the FW of Being a Mathematics Student

In this section, I discuss the positionality of Zahra's identification with mathematics further and consider how it is evident in her account of her past and present experiences of mathematical learning and her future designated identity. My analysis indicates that these positional identities are: i) positioning herself as special (see above); ii) aligning with the teachers in the FW of being a mathematics student at school (past); iii) aligning with the lecturers at university and subsequently misaligning with her fellow students in the FW of being a mathematics student at university (present); and iv) becoming a successful mathematician in the imaginary world of the future (designated identity).

### 6.4.1 Past: Positioning herself as Special and Aligning with Teachers at School

Zahra recounts her first memory of mathematics back in elementary school when she was in grade 5 at age 11. At this point, she understood that she was different from other classmates: "when I was in grade 5, I was ahead of my classmates in doing mathematical equations" she explained. Thus, she positions herself as a special student when she compares herself with others in her mathematics class. She also talks about her unique identity at junior school in terms of becoming the best in a mathematics competition and she speaks of "achieving the highest score" and “becoming first in her home town” in this respect.

In describing her experience at junior high school below, Zahra describes how she proved Pythagoras’ theory and showed this to the teacher. She reports that this event triggers a nickname of Pythagoras which then became a 2nd person identity (Sfard and Prusak, 2006) assigned to her by other students and which she then aligned with, ‘making sure mathematics is my ultimate choice’. In addition, we again see Zahra use the story of solving Pythagoras theory as a tool to construct her positional mathematical identity as different or ‘special’ (i.e. proving her exceptional ability which marks her out from the other students in the class):

*Z: I proved that Pythagoras theory, with all of its 380 evidences, was wrong. When I showed this to the teacher, she told me this is impossible and I asked her to show my mistake. She could not find the error in spite of lots of efforts. I think I showed it to somebody else but she/he could not find the error. Later, exactly after finishing junior school in summer time, I found out my own mistake.*
*N: Ahan, you found your mistake?*
*Z: Yeah, after this incident I became familiar with the name of mathematicians and I started to read their biographies. Other students also called me Pythagoras, making me sure that mathematics is my ultimate choice.*

Later in the interview, Zahra also discusses her relationship (alignment) with another mathematics teacher at school: a PhD student who acts as a potential figure that she can relate to as someone who was guiding her pathway to study mathematics. This teacher seems important to Zahra because she recognises (and legitimises) her 'passion towards mathematics' and the fact that 'I like mathematics very much' and this motivates her to go 'beyond the school books' and 'do more research'. At the same time, her relationship with this teacher gives her the opportunity to become a 'teacher' for other students in the class, again signalling her position as special or different from other students in her class who are taught by her:

*After some times, she noticed that I like mathematics very much and she really encouraged me on that. Even it got to the point that she told me to hold a class for students and I taught in the class instead of her. Therefore, my passion towards mathematics was getting stronger. She helped me to do more research on mathematics and I went beyond the school books. I was a bit lazy but I really liked mathematics. Then, at the first year of high school I made my ultimate decision towards studying mathematics.*

To summarise, Zahra's account of her experience with mathematics at school further strengthens her mathematical identity as unique and special (through her intrinsic love), and she uses particular figures (Pythagoras and the PhD student teacher) to further legitimise her claim here. Inevitably, this involves positioning herself as different from other students and her ability is also crucial ('I was ahead of my classmates'). I will now discuss how Zahra constructs her mathematical identity and uses this, focusing on her experience studying mathematics at university.

### 6.4.2 Present: Aligning with the Lecturers and Misaligning with the Students at University

In self-authoring her identity in the FW of being a mathematics student at University, Zahra describes how enthusiastic she is in lectures, particularly those taught by certain lecturers (those that are 'good'). Here, she positions herself as an active student within these classes. But this enthusiasm has consequences in terms of how her classmates view her behaviour and we begin to see some 'troubles' in her story. For instance:

> *As an example there are some days that I have classes with the good lecturers and I love the lesson. Extremely enthusiastically I get up early every day even without any alarm clock. On the way I study mathematics, indeed I live with it. I attend the classes, remark and challenge on the mathematical issues. Even some time I become so annoyed that others cannot stand me. I don't know what the reason behind this is? But it may result from their jealousy.*

Here, Zahra tells of her troubles as being positioned negatively by her classmates but it seems she uses this in the narrative to further construct her mathematical identity as unique and special. Note how her perception that 'others cannot stand me' which 'may result from their jealousy' is juxtaposed with how she reports her behaviour on the way to and in class - 'I study mathematics, indeed I live with it'. The latter remark suggests once again that she has an inner passion which permeates all aspects of her experience at university (i.e. travelling to university/sleeping) and that this positions her as different from others. This is further displayed in a sub-story she tells of an encounter with other students:

> *They told me 'you answer all the questions and the lecturer thinks we all know the lesson'. So my classmates think because of me lecturers do not re-explain the materials when they are supposed to do so, and my classmates tell me 'do not show your understanding to the lecturers'. For example, I remember last term I participated in a class named Mathematics Analysis which was ahead of my level. I was so good at that course that I could answer many of the questions. This capability of mine was so annoying to the classmates that they sent posts on Facebook to prevent me from making any comments [in class]: 'those who do not belong to this class stop remarking'.*

Here, again there is a clear sense of being positioned as different from her peers to the extent that she tells of how they have constructed her as 'not belonging' to their FW of studying mathematics at this university. When Zahra points out that she is studying in classes 'ahead of her level' and ‘I was so good at that course that I could answer many of the questions’, she discusses her unique mathematics identity in practice. This then mediates unwillingness on her part to work with her classmates because they are not the same as her:

> *I like group work if people in the group like mathematics. But at the moment I do not prefer to do things in a group in that I have no identical people around me interested in teamwork. Unfortunately I see no such people around myself.*

In fact, there are moments where she identifies more with lecturers on her degree programme than with students: "I prefer to work with lecturers rather than students". Thus, for Zahra, being special involves being positioned as an outsider in her peer group and this then further resources her exceptionality (she is able to align with those in higher positions such as the lecturers). Therefore, by positioning herself as 'not like them' it seems she accepts there is reciprocity in her 'differentness' but this then enables her to continue narrating her identity as special.

### 6.4.3 Future: Becoming a 'Successful Mathematician'

As mentioned above in my brief summary, Zahra reported that she intended to achieve the 'Fields Medal for mathematics' along with 'national and International medals' which suggests a future imagined or designated identity of becoming a ‘successful' mathematician (recall her earlier comment about becoming famous, too). Moreover, when asked to identify role models who have inspired her aspirations, Zahra considers some eminent mathematicians, namely Alexander Grothendieck and George Cantor, as symbolic figures in her life. In one sense, they act as role models but, in another sense, they are figurative identities in terms of symbolising what she wishes to become (famous figures from history).

*N: Who is/are your role models?*
*Z: From the past, among mathematicians, one is Cantor and another one is Grothendieck. I have chosen them not because of the social status they had, because I want to reach to their level of understanding.*

It is interesting that Zahra identifies with these 'white male mathematician' figures, here, in narrating the kind of 'successful mathematician' she wishes to become. This is evident in her identity statement 'I want to reach their level of understanding', which implies that she relates to these symbolic figures as similar to her in terms of their internal passion or love of mathematics. This is interesting because both Cantor and Grothendieck are white male historic figures who worked in somewhat different circumstances to Zahra (both in time and location) and, therefore, we might anticipate that it is somewhat difficult to imagine oneself following in their shoes in present day Iran (especially when, as noted below, an Iranian female had recently won the Fields Medal). On the other hand, Zahra's claim to relate to these figures indicates their symbolic status in the world of mathematics given both men capture beliefs about mathematics which she can relate to (see above sections on the aesthetic beauty and intrinsic love of mathematics); becoming a mathematician, for Zahra, means identifying with these figures no matter how distal they are to her own situation.

However, Zahra also talks about Dr Maryam Mirzakhani as a symbolic figure in her story, who she positions as a role model:

*I have also a woman role model, Mrs. Maryam Mirzakhani who achieved Fields medal in mathematics. She is the greatest woman in mathematics in the world.*

But at the same time, Zahra questions the figure of a woman in the world of mathematicians.

*N: Well, don't you think that women's positions are changing gradually? I mean women are reaching to the same level as men as well? Like Mrs. Mirzakhani?*
*Z: For example because of Mrs. Mirzakhani we cannot predict that things are changing. Maybe there is nobody like her again, so we cannot define a specific procedure for it.*

As can be seen from the dialogue above, there is resistance to the idea that Dr Mirzakhani could be a world maker (i.e. she is positioned as unique and therefore does not represent a shift in culture). As such, I argue that, whilst Zahra is happy to align with Cantor and Geothendicke as they are symbolic of the 'specialness' that she is driven towards becoming, there is no sense in which she assigns the same status to Mirzakhani.

> *I and other female mathematicians are in minority. Many mathematicians are men. By ignoring the exception, we can say men are better in mathematics because of the better mathematical ability.*

In this way, Zahra challenges Dr Mirzakhani's position or power in a masculine world of mathematics ('ignoring the exception') because, ultimately, she believes men are better at mathematics (they have 'better mathematical ability').

To summarise this section, Zahra's narrative is dominated and centred around her love of mathematics in the past, present and future, and it is this love which she believes marks her as different or special from others (mentioned in Section 6.3.1). Therefore, her account has some similarities with other literature like Rodd et al. (2006) who present high achieving girls as 'being special in mathematics'. They argue that "their gendered trajectory is characterised in terms of being both 'invisible in the dominant university mathematics community and yet 'special' in their self-conception" (p.35).

## 6.5 Key Cultural Models Relevant to Iran

Having identified Zahra's MI as being special and different, which is rooted in her intrinsic love or passion for mathematics, we might then ask what cultural models are drawn upon in her narrative to support this identity and how they facilitate or hinder Zahra's identity work as she negotiates the social and cultural circumstances in which she lives. As mentioned before, cultural models are socially shared beliefs and values rooted in socially shared communities such as family, society and even in the world. Cultural models in this case are part of choosing and studying mathematics in Zahra's story and, whilst some might be generic (e.g. mathematics as

beautiful), others are more culturally specific to Iran. The aim of this section is to display these cultural models in order to answer RQ1 regarding the presence of Iranian cultural-historical-economic structures and conditions in female STEM students' narratives regarding their choices, experiences and aspirations. In doing so, I will also show Zahra's resistance of certain Iranian practices and beliefs as she narrates her tale of uniqueness. I will argue this resistance highlights a sense of agency in her story. My aim here is to make these cultural models explicit and to show the complexity or conflict in Zahra's account as she challenges dominant ideologies (rooted in Iranian society) but aligns with others (global norms) as part of her self-authoring (as per RQ2).

### 6.5.1 The Role of the Family in Choosing University Degree

Zahra told several sub-stories throughout her interview about her family and their influence and behaviour towards her when making her choice of university and degree programme. In general, I would describe this as a form of collective decision-making where various family members (even distant family) 'have a say' in what degree or university should be chosen. I argue that this is a cultural model because a) it was a common theme mentioned by several other students in their interviews in different ways and so was socially shared, and b) my own experience of transition into university gives me insights into the role families play and the discussions which take place within families when women, such as Zahra, make their choices regarding university. Furthermore, I also argue that this cultural model regarding family decision-making is ideological in that it can both (re-)produce the positioning of middle class women in Iranian society (i.e. as having pre-determined futures) and serves to enhance/maintain status of a family through choosing the 'right kind of degree or university'.

An example of this cultural model is in Zahra's account of her experience when the result of Konkur was issued and she was not accepted into her preferred university (Hafez University). The following text shows that the position of failure was assigned to Zahra by her family when this occurred:

> *Once seeing the results, I cried. My mother was the first person who became aware of my result. She told me 'my dear daughter if you want to be accepted at Hafez University, you must study one year more'. Then my sister said to me 'you accepted mathematics at Jesus University, this programme is of no use'. Finally my brother told me that 'you are a failure as you couldn't make it to go to Hafez University'. Everyone in the family was telling bad stuff about me, which was really bad.*

Zahra's account here demonstrates a sequence of input from various different family members, all of whom position her as a failure 'needing to study one year more' because she has not achieved high enough marks for a higher status university. I argue this kind of 'practice' is culturally specific because it demonstrates the family's sense of ownership or their 'right' to determine their daughter's/sister's future in order to ensure it meets their requirements of a high status career/degree/university. Zahra's report indicates that this practice leaves little space for her to exert independence or choice in her decision-making by her family, and if she wishes to have this she must resist their positioning. Although in a western context such parental influences or expectations towards student's university choices and aspirations are apparent (e.g. Hernandez et al., 2008), the sequence of input from different members of the family suggests this influence is a more structured dialogue where each member has a turn to express their view.

This contrasts with westernised humanistic cultural values of 'independence', 'free choice', etc. For instance, a UK based study by Hernandez et al. (2008) observed the role of family in choosing mathematically demanding programmes at university among 40 further education college students both male and female. Their findings indicated that, whilst students reported their families do have an influence on HE decision-making, they do not explicitly play a major part: "the possibility of going to university was there for them to take if they wished to" (Hernandez et al., 2008, p.157). One student explained this as "there is nothing that is pushed. It's like 'if you want to do this, you go and do it and you do your best at it', and they are quite supportive this way" (p.157). However, in Zahra's case, she reports a sense that her family has the right to determine their daughter's/sister's future and that this takes place through a dialogue where each family member states their opinion (shown in Section 6.5.2). I argue that this reflects the family's sense of ownership to determine their daughter's future.

Therefore, to maintain her mathematical identity as someone who can see the beauty of mathematics and has an intrinsic love of the subject, Zahra reports her need to resist her family influence. Below, Zahra tells me she made up her mind to pursue mathematics at university when she was in first year at high school (year 9), but her family did not support her decision:

> *My parents disagreed with my decision to study mathematics and from my second year in high school they told me to pursue empirical science rather than mathematics. I told them I don't like science and so they accepted that I study mathematics in high school. As far as I can remember my family has always disagreed with my decision to study mathematics. They suggested me to choose empirical science to be a doctor, just to have social prestige.*

What can be concluded from this text is that the main reason for the family's input to decision-making is related to social status. Being a doctor serves a better social status but she resists this 'in practice' and chooses mathematics instead. Thus, she positions herself against the family's pressure/influence. This shows how she resists the norms that are culturally mediated by the Iranian context such as "family's interference" and "prestigious status of being a doctor".

This theme regarding family influence also came up when Zahra discussed the reasons why other students attend university. For instance, in the quote below, she is critical of female students who come to university only to obtain social status and who are therefore not interested in their chosen subject. This is not satisfactory for Zahra who loves mathematics only because of its nature. Thus, she resists this cultural model.

> *N: If you think girls don't like mathematics why do they come?*
> *Z: As I said before, it is to do with social status. Some students come in without any interest and they don't study as well. This is the fashion of going to university.*
> *N: So, going to university is more important than the subject?*
> *Z: Yeah, some, their family force them to come. Some.. they are here because they want a future career or fame, without having any interest.*

When Zahra notes that "their family forces them to come" she again refers to the family practice of owning their daughter's decision-making in terms of choice regarding university (which I referred to above). Her use of 'they' and 'their' signals these students as 'others' who are not like her; like the peer group who she does not align with, they are others since they are distinct from her own intrinsic love for her subject. As before, I suggest, therefore, that this 'othering' process is resourcing her own mathematical identity as authentic and genuine.

### 6.5.2 The Social Status of Engineering

Related to the above discussion of status and family pressure is the status that Engineering has as the top subject or degree programme in Iranian universities. In Chapter 2, I have shown how entry onto engineering programmes in Iran requires students to be in the top rank in the Konkur. Such stringent entry grades reflect/translate into the belief that Engineering is a more prestigious subject because it brings about good career prospects in the future (see evidence of this in Chapter 2). Engineering is also seen as a better subject through Zahra's family's eyes: 'they told me I could find a better job in engineering', she explained, whereas 'mathematics has no good future' and is still not legitimated by her parents, despite her enjoyment/interest in mathematics at university: 'now, my mum and others notice that I enjoy mathematics, but still they have no faith on my future in mathematics'.

Therefore, there is a sense that Zahra is not only positioning herself against her family's preference of degree programme but against the social status that engineering holds over mathematics in Iran. For instance, in the following quote she discusses deliberately not studying for the Konkur in order to ensure she did not achieve high enough marks for engineering:

> *I knew that mathematics doesn't need a good grade compared with engineering, thus I didn't study that much and I knew I would be accepted in mathematics anyway. On the day of major-selection, my family didn't allow me to choose mathematics. My sister suggested I choose mathematics at Hafez University9 as the first choice and engineering majors at Molavi University second. I said no, I am not going to do that. My sister was the main person who*

*9* Hafez University is the best university of Iran.

*disagreed with it. She tried to convince my parents to not let me to go to study mathematics.*

Here, Zahra reports that she has not only resisted her family in choosing to study mathematics at a lower status university, but she has also resisted the notion of 'engineering as a better subject to study'. In so far as this notion is socially, culturally shared (e.g. through the ranking of the Konkur grades), we can say it acts as a cultural model which she resists (in chapter 7, I will show how this cultural model was shared by other participants who positioned themselves in relation to it in different ways).

### 6.5.3 Persian Divination

Another practice which I argue is rooted in Iranian culture is the role of spiritual practices in informing decision-making at key moments in life. Whilst this may be common in other religious states[10], in Iran this takes on a specific form where individuals will consult with Hafez, an Iranian religious poet, not only for support or strength in making choices that are difficult but also as a means to discover which decision is the right way to go. "When one opens Hafez's Divan with a nagging problem in the mind or heart, the couplet or the whole poem that appears is a subtle and sometimes powerful explanation or piece of advice that is exactly what was needed" (Paul, 2014, p.646)**.** The aim of Hafez's poems is to seek the love of God, and these poems can be found in almost every Iranian home – and more than 600 "years after his death, the writer still offers an insight into his country's identity-" (BBC news, 2014).The divination practice is when one opens the book randomly, identifies a random verse, and tries to make sense of the verse, and I would say that most Iranian's comply with the outcome of divination.

However, in the extract below, Zahra talks about resisting the outcome of 'divination from Hafez', in order to pursue her love of mathematics, which indicates the strength or ownership, she takes over her mathematical identity. She also speaks of resisting other religious influences here (e.g. a religious person on TV):

[10] This often refers to the practice of opening the Quran in order to take answers from the text about some problem known as Istikhara.

*Z: I remember on the day of selecting course for university, we had time till 10 pm to change our subjects. On that day I was extremely hesitant about what I had selected, quite vividly I could remember that everything around me was tempting me to alter my decision. As an example, there was a program on TV which called 'to God' and Mr X was explaining that what you decide on must be in accordance with the society's need not with your desire and interest. I remember this clearly; when I noticed he is saying the same things as others ... it made me angrier. At 10pm I had one hour to change, I decided to get divination from Hafez, to give me strength. But the meaning of the poem was that the way you have chosen is wrong and you should change it till not get too late. It was a really bad feeling.*
*N: Are you serious? What happened that you didn't change? Was it your love to mathematics?*
*Z: I didn't choose any other subject.*

In this brief sub-story there is a clear sense in which Zahra perceives her decision to study mathematics goes against the beliefs of her family and society. 'I was extremely hesitant' and 'it was a really bad feeling' indicates this resistance which was really difficult for her. We can also see that she recognises authority in the TV programme, the Hafez divination and her family, and perceives that these are in agreement with each other (i.e. against her decision). These authorities are seen by Zahra to be able to determine an individual's choices and, in so far as they are part of culturally shared practices (e.g. consulting Hafez at difficult times), then I can establish them as cultural models which inform behaviour one way or another. These are ideological in that they embody a particular set of structural power relations with key figures like Hafez as holding authority over others (e.g. students like Zahra). Thus, I argue that resisting such cultural models because they do not support her love of mathematics is a key theme in Zahra's story and it is for this reason I have identified it as 'success against the odds'. Overcoming such difficult encounters further resources her belief that she has an intrinsic passion for mathematics which must be pursued at all costs.

### 6.5.4 Moving Abroad

Another common theme which emerged both in students' responses to the surveys and across the interviews was the expectation that one would need to go abroad in order to be successful in a given career. According to Bloomberg news there is a

shared social concern that too many Iranian students are leaving Iran to go to western countries in order to continue their education to postgraduate level and search for a better job:

> *Tens of thousands of Iranians have left the country of 77 million in recent years, largely for Europe and North America, in search of jobs and higher salaries. During the past two years, at least 40 percent of top-performing students with undergraduate degrees in science and engineering left the country to pursue advanced degrees (Motevalli, 2014).*

Furthermore, Torbat (2002, p.273) states that the "brain drain from Iran to the US, measured by migration rates of the individuals with tertiary education, is the highest in Asia"[11]. In this sense, I argue that the notion of moving abroad to be successful is also a cultural model in that it is socially shared as an expectation, particularly for many middle class aspirational women in Iran.

Below Zahra explicitly discusses the idea of 'moving abroad' and conflates this with studying at university, indicating that both are seen as crucial to success in careers. She is of the opinion that studying at university and going abroad have become epidemic in Iran:

> *Z: Going abroad is a norm; unfortunately people think that there is no other option except academic studies at academies. While, there are, of course, some other ways apart from studying and universities and going abroad. They cannot imagine a successful life without studying and university.*
> *N: Do you like the idea of living or studying abroad?*
> *Z: Living not. I don't like living alone. I want to live beside my family and my relatives. It is difficult to live somewhere else lonely. But for studying I haven't decided yet. If one day I come to this decision that I want something special in mathematics which is not achievable here, I will go to achieve it and come back here again. But I haven't come to this decision yet.*

Therefore, we can say this is culturally specific belief and it's a belief that she must deal with, in narrating her designated identity as a successful mathematician. What is interesting here is that, despite her resistance to family and social expectations of her

[11] "The tiny country of Fiji that has a higher rate than Iran was ignored due to its very small size" (Torbat, 2002, p.273).

described earlier, Zahra still talks about needing to live beside her family. She states that she prefers to live in Iran in the future unless she has to follow a particular field in mathematics that is hard to access there.

Thus, Zahra appears to resist the cultural model of living abroad as desirable because it involves 'living alone' and being 'lonely'. Only her desire for 'something special in mathematics' will persuade her to go abroad and even then she will come back. Thus, her designated identity of becoming 'the best' may potentially require some major sacrifices which she anticipates having to deal with in the future. In Chapter 8, I discuss the cultural model of moving abroad in relation to the narratives of the other participants in the study; this will allow me to explore how this cultural model is part of a system of capital exchange for my participants. It will also allow me to highlight how the participants narrate this cultural model quite differently which appears to link to their particular imagined identity.

To summarise, in this section I have highlighted how Zahra's story includes particular cultural models which are heavily situated in the Iranian cultural context, which includes 'the role of family in students decision-making regarding university degree programme'. Here, I suggest this cultural model is derived from a particular ideological standpoint regarding the relationship between parents and daughters in Iranian middle class families and what is expected and acceptable for daughters to do/achieve. This also underpins the cultural model that 'daughters attending university can enhance one's social status' and, in Chapter 7 and 8, I highlight the forms of capital at play using this cultural model. The cultural model regarding 'the social status of engineering', which Zahra resists, is rooted in the socio-economic structure of Iran outlined in Chapter 2, whereby engineering is seen to be a prosperous career with job security and so has become culturally prestigious. Economic capital may have become cultural capital here so that, although many women are not able to use their engineering degrees to gain employment in Iran (see Chapter 2 labour market data), it still carries prestige which is above and beyond the financial gains it offers (this is apparent in the family belief in engineering as a prestigious subject). The cultural model of 'moving abroad' is also socially shared amongst many Iraninan middle class women and in Chapter 8 I discuss how this is a product of the structural contradictions regarding educated women with few labour

market opportunities. What is more, in this chapter, we see Zahra's account of narrating resistance to the above cultural models as a manifestation of her perceived agency against the conditions of her local context; such agency seems to be derived from the contradiction between the restrictions this context places on her and her 'intrinsic love' of mathematics which she feels compelled to pursue.

## 6.6 Conclusion

In general, we can conclude that Zahra's narrative is dominated by her MI which is located in her intrinsic love of mathematics and a need to be special. Feeling different (special) and becoming 'the best' are themes consistently repeated throughout her interview data. Nevertheless, this is not a story without troubles and Zahra speaks of family and university's classmates contesting her MI. The challenges she describes involve resisting some cultural models which, I have argued, are situated in the Iranian context in pursuit of a version of mathematics dominated by white, male historical figures who are symbolic of her intrinsic passion for the subject. Given Zahra's resistance to what I have framed as Iranian cultural models, her case indicates the need to consider cultural models which are not only specific to the local context but also operate beyond this; that is, a more globalised account of identity and cultural models which not only recognise the mobility of the individual (e.g. migration etc) but also cultural practices (e.g. mathematics) which have both global and local values. This can help to explain why Zahra does not give symbolic status to Maryam Mirzakhani despite the fact that she represents the designated identity that Zahra narrates. Arguably, the dominant white male cultural narrative around mathematics overrides a locally produced Iranian symbolic figure in resourcing her MI. In Chapter 9, I discuss further the relationship between local and global influences on my participants' narratives as a means to understand the complex social structures which mediate their MI. In the next chapter, I move on to discuss the narratives of engineering students in order to consider the similarities and differences between MI in mathematics and engineering programs.

# Chapter 7: Engineering and Mathematics in Iran

## 7.1 Introduction

In this chapter, I examine whether the themes, cultural models and figures discussed in Zahra's narrative are present within the data collated with other students in this study. Firstly, I discuss some of the brief survey data I collated with EE students and mathematics students. The purpose of discussing this survey data is to establish the extent to which the students' reasons for choosing these degree programmes are part of a wider, culturally shared narrative about which subjects have value in Iran. The aim is to present an overview of the women's choices and aspirations, and to link these together to further broaden the narratives (potentially searching for shared FWs) of Mona, Maryam and Hiva.

I have chosen to focus only on mathematics and EE here because I felt that these two subjects juxtapose each other in an interesting way (mathematics requires lower entry grades in the Konkur whereas EE demands the highest grades of those on the science/mathematics track). As such, I am interested in whether choice of these degree programmes is present as a form of capital in the students' narratives and the extent to which it acts as such, and/or is accessed using other forms of capital. This chapter, therefore, addresses RQ1a: What forms of capital are apparent in female students' narratives about their choices, experiences and aspirations? In addition, by answering this question I am also interested in how the students position themselves in relation to the forms of capital at play in this local context, and particularly the extent to which they align or resist with the positions such capital affords. For this reason, I also consider the extent to which the students display a sense of agency in their narratives about their choices, experiences and aspirations (RQ2a).

## 7.2 Brief Survey Findings

Here, I report on some of the findings from the survey I conducted with students on all of the programmes involved in this study. As a reminder, the survey was initially developed as a tool to identify students with potentially interesting narratives

regarding their relationship with STEM who would then be approached to participate in the main study. As outlined in Chapter 5, this strategy was only partially successful in that it produced only a limited number of participants (mainly from engineering) who wished to be involved. However, the survey did yield some information about the students' reasons for choosing their degree and, therefore, I feel it is worthwhile reporting such data here. It is not my intention to use this data to claim overall trends or patterns amongst Iranian female students, but it does provide some information on the shared ideas and beliefs at work amongst students on both mathematics and engineering programmes (useful for identifying FWand cultural models in my narrative analysis later). Table 8 below presents the factors which students reported as influential on their choice of degree programme (these responses relate to question 1 in the survey which asked respondents to identify the main reasons for choosing their subject). This data is derived from qualitative responses to an open question and a full list of survey responses of both EE and mathematics students is provided in Appendix 8. I have used thematic analysis to analyse these written responses, whereby I read the responses, looked for common ideas and developed a series of themes. I then revisited the survey responses to check for any further data which connected to these themes.

**Table 8**: Reasons for choosing degree programme

| | | EE (N=11) | Mathematics (N=20) |
|---|---|---|---|
| Influenced by other people | Family | 1 | 1 |
| | Father | 3 | |
| | Sister | 1 | |
| | School Advisor | 3 | |
| Influenced by prior grades (including Konkur) | High grade | 5 | |
| | Low grade | 1 | 10 |
| Interest in subject | Interest | 3 | 11 |
| | No interest | 4 | 2 |
| Other influences | Social need | 3 | |
| | To attend good university | 1 | 7 |
| | To stay in Tehran | | 3 |

Moreover, in the survey, the students also reported a range of careers which they aspired to, which included teaching, banking and engineering. Given the low number of respondents who completed the survey, I could not identify any dominant responses within or between the EE and mathematics groups, although a group of mathematics students (5 respondents) were interested in teaching and a group of EE students (5 respondents) stated they were interested in becoming electrical engineers (unsurprisingly). Amongst the mathematics students, there were aspirations related to becoming a teacher (5), a banker (4) and a lecturer (4). Teaching was the most popular career, with 5 respondents declaring that they have an interest in this career. Thus, mathematics students' aspirations connected to the lower status of the subject (requiring lower entry grades), since teaching is considered a lower status career in Iran. This claim is also supported by Mona and Zahra's interviews in which they describe teaching as limited (e.g. Mona spoke about the lower minimum wage for teachers). However, not all of the mathematics students were interested in teaching,

with some wanting to study for a PhD (7 respondents) and/or pursue careers such as lecturing or financial management. There were 5 EE students in this group who stated that they have aspirations which involve becoming an electrical engineer. In fact, some of the EE students stated they have aspirations for an EE career, despite reporting that they did not like the subject. This paradox is visible in Maryam's story when she talks about not being interested in EE but choosing it in order to leave Iran (see Maryam's story below). Nearly all of those who completed the survey stated that they intended to continue to further study and obtain postgraduate qualifications as well as their undergraduate degree. Thus, I argue that this slightly broader sample appeared to have high aspirations in relation to their future educational achievement, which aligns with the evidence outlined in Chapter 2.

### 7.2.1 Survey Data: Mathematics Students (N=20 students)

10 mathematics students stated that they had chosen mathematics due to attaining lower grades in the national Konkur exam for university entry (Table 8, grade influence). Therefore, this was a recurring theme in their open responses and was far more frequent than in the EE student response group. For instance, one student stated “I chose engineering but ended up with mathematics”. Among these 10 students, 7 mathematics students declared that they wanted to study engineering but ended up studying mathematics due to achieving lower grades and among these 7 students, 4 of them mentioned that they liked mathematics as well as engineering. Thus their affiliation with mathematics led them to aspire to engineering (although they did end up studying mathematics).

In the previous chapter, Zahra refers to mathematics having lower status because it has lower entry requirements when she discusses her family’s preference for engineering. She also stated in the interview: "I knew that mathematics didn’t need a good grade compared with engineering, so I didn’t study that much and I knew I would be accepted in mathematics anyway". This theme also appears in Mona's story below where I consider the value of a university mathematics degree and how this relates to entry grade requirements.

Also, in the survey, 7 students reported that they had chosen mathematics in order to enter a good university (Table 8). Thus, within this particular degree programme (mathematics), a group of students appeared to share a common assumption that the status of the university matters when choosing undergraduate study. From this, we might infer that choosing to study for a mathematics degree in this context provides access to a certain type of university rather than a certain type of degree, and these particular students aspired more towards a better university. For instance, respondent M9 wrote "to be accepted in public university (my aim was public university)" in response to Q1 (the main reasons for choosing the subject). This conclusion can also be supported by Mona's survey data as she wrote that "personal interest towards mathematics led me to choose this subject and the suitable position of the university in terms of ranking and geographical state (situated in capital) determined my university choice as this one".

Quite interestingly, another group of mathematics students stated that they were interested in their subject (11 out of 20 students) compared with only 3 (out of 11) EE students who made similar comments (Table 8, interest influence). Thus, despite the fact that some students chose mathematics because they had received lower grades in the Konkur, a good number of mathematics students reported that they were quite interested in their subject. As an example, M10 wrote in the survey "since I have always liked to do things fundamentally I chose mathematics; I felt that mathematics is a kind of intellectual subject and I have been always interested in intellectual activities". M15 also stated she was "interested in pure science subjects and had no motivation towards engineering subjects".

### 7.2.2 EE Students (N=11)

Amongst the students who completed the survey from the EE programme, 5 of them reported that they had chosen EE deliberately due to the fact that they had achieved 'good grades' (Table 8, grade influence). As an example, E3 wrote in the survey "I liked physics very much but at the time of selecting course, when the advisors saw my grade they told me to study EE because there would be no suitable job for basic science courses". Thus, this student appeared to be informed by others who viewed

Physics as having limited value in terms of future employment and, therefore, having lower status than engineering (which demanded higher grades). Another student, E1 wrote that "I chose EE because of some various reasons such as the high grade I obtained, the things that my advisor told me and my sister's consultancy (she studied this subject as well)". Therefore, it seems that achieving high grades is associated with studying EE by a number of students, thus indicating that it might offer some insight into the cultural models students draw on in narrating their choice of the subject. I will consider this further in this Chapter.

Four EE students declared that they did not have a particular interest in their chosen subject (Table 8, interest influence). As an example, E5 stated "I did not like it [degree choice] but because of my grade [Konkur] and the possibility of having better job I have chosen it". In response to the question asking for a movie title to describe their life, E9 wrote "I didn't follow my interest, if I followed my interest, I would be satisfied now". Only one student (E6) stated that she liked EE because of its nature, as she perceives it to be creative and the degree contains some modules which give her a sense of enthusiasm. 3 EE students stated that they like mathematics and this encouraged them to study EE (see the quote from E4 in the paragraphs below).

The influence of others in choosing their degree programme was also explicit amongst a group of the EE students (8 in total). This means they reported that their choice to study EE was constructed through the influence of advisors, family and the needs of society. The influence of others was largely absent from the mathematics students' survey data. 3 EE students mentioned their advisors as someone who guided them towards EE because they achieved high grades in the Konkur (Table 8, people's influence). For example, E3 stated "I like physics more, but when the advisors saw my grade told me to choose EE instead". One student (E5) reported being motivated by her father's occupation (role model) and another reported she was influenced by her sister who is working in the engineering field (see quote from E1 above) (Table 8, influence by people).

2 students reported that they had been advised by their father to study engineering (E4 and E10 (Hiva)). In response to question1 in the survey, E4 stated "this was the

subject that I had been accepted for and my father liked that I become an engineer and I like mathematics and this subject was the only subject that had lots of mathematics in it". However, E4 also stated that she did not wish to be an engineer in the future but would rather become a lawyer, thus indicating some degree of tension between the wishes of her father and her own future career aspirations.

This tension was further commented on by E9 and E10 (Hiva), who reported that they enjoyed art such as theatre and clothes design but their parents did not allow them to study these subjects so they were directed by family to study engineering (Table 15, Appendix 11). E9 mentioned that "my family was not eager that I study art and they prefer that I become an engineer". E10 stated that "I noticed that I am in love with theatre, I talked to my father about this and he told me that the best way is to be an engineer and then with engineering thinking enter in to the field of art, but indeed I don't know whether I chose the right path or not!". Therefore, it appeared that some of the EE students had conflicted feelings about their father's influence on their degree choice. However, this was not the case for all EE students. For instance, E2 believes she can contribute to Iranian economy to reach self-sufficiency. Thus, she locates her choice of degree in a broader national context regarding the academic profile needed to produce labour power that can achieve development. This was an unusual response to the survey because of the specific reference to the country's economic status (i.e. the need for self sufficiency – academic development) but it was not unusual in that most of the responses referenced broader structural conditions in Iran (e.g. the exchange value of Konkur grades, patriarchal relations governing degree choice etc).

In summary, this brief survey data indicates some interesting shared themes which appeared to have some commonality across the group of respondents. They provide evidence which suggests that such themes (reasons for choosing, etc.) are shared by a number of students on EE and mathematics programmes. I now move on to present further narrative analysis in order to unpack how these different reasons for choosing EE and/or mathematics are part of a wider cultural narrative. For instance, when we consider the higher status of engineering, evident in its high entry grade, we need to consider how this status may be implicated in the way students speak of their reasons for choosing EE. As such, I argue that the survey data has provided background

information regarding the beliefs and cultural models students draw on to narrate their choice of degree (and aspirations), which helps to situate the narratives that I will now present.

## 7.3 Narrative Analysis: Mathematics Vs Electrical Engineering

### 7.3.1 Rationale for Selected Narratives

In this section I will focus on three students: Mona, a mathematics undergraduate, and Maryam and Hive, who are both studying EE. The purpose is to explore how these students understand their degree programmes as a form of capital and how this is implicated in the way the construct their mathematical/engineering identity.

There are two mathematics students that I interviewed in total (Zahra and Mona). Zahra's story was described in detail in Chapter 6. The analysis here focuses on how Mona self-authors her identity as a mathematics student and how mathematics is positioned as a lower status subject when compared with engineering.

As was the case in Zahra's story in Chapter 6, various different resources are drawn on in Mona's story to support her identity as a mathematics student. Her love of mathematics and her mathematical ability are themes consistently repeated throughout her interview data. Like Zahra, Mona had chosen to study mathematics over engineering as she had always liked the subject and in her survey response she mentioned 3 different mathematics-related careers that she was interested in (mathematics teacher, working in the stock market, and mathematics lecturer). However, in her interview she also made some statements which suggested that her decision to study mathematics had come at a cost in that that she now believes studying mathematics has 'no future'. This position presents an interesting contradiction to the stated career aspirations she wrote about in her survey response and, therefore, I felt it would be fruitful to consider how she perceives her degree in terms of capital exchange as outlined in Chapter 3. In addition, such negative perceptions regarding her future did not appear to dissuade her from wanting to

study mathematics in the future, which presents another contradiction, again making her story interesting.

Maryam is a Year 2 EE student who spoke of her plans to move abroad. I have chosen to present my narrative analysis of her case here because, during the interview, she positioned herself in alignment with the perspective that EE carries high social status (which I have argued is evident in its higher entry grade). Therefore, I felt her narrative might help us to understand how EE specifically is positioned as holding capital in the Iranian university context. In addition, despite reporting a lack of interest in the subject, Maryam spoke of engineering being part of her future since she wished to move abroad and become a successful woman (note that the latter designated identity is not associated with a future in Iran). Thus, the purpose of Maryam's story is to show how she uses EE as symbolic capital, which can be exchanged for employment opportunities abroad, this makes her case interesting. Finally, Maryam reported that she is interested in Art and Cinema but her family would not allow her to study these subjects since they hold limited value in the labor market. Thus, again, it appeared that she perceived her family to play a significant role in her choice of degree subject, influenced by systems of capital exchange.

Lastly, I have chosen to present a narrative analysis of Hiva's interview because again she spoke of the status EE has as a subject and that this enabled her to continue her real issue working in underground (working secretly as it is not legally permitted to work) theatre in Iran. Hiva argued that, for her, performing art and studying EE are concordant with one another and that she can do both at the same time. However, she also appeared aware of the status of EE and mentioned that she had chosen it due it being a 'prestigious subject'. Again, her interview indicated a conscious use of EE as a form of capital which could provide her room to exert some agency over her own life. Nevertheless, the role of other people in shaping her choice of EE is significant in her story and she talks about her father's influence in this respect. For this reason, I felt her case would allow me to look at how father-daughter relationships function in relation to students' choice of degree, experiences and future aspirations.

### 7.3.2 Mona's Story

Mona has chosen to study mathematics at university and at the time of the interview she was a senior student (final year). In the quote below, Mona suggests her preference for studying mathematics was influenced by her love of the subject, her mathematical ability and her brother who also studied mathematics. In addition, in self-authoring her decision to become a mathematics student, she draws on her experience of attending a 'Tizhoshan school' (a selected entry, academic focused school) and her attainment of a high grade in the university entrance exam to identify herself as 'good enough' for mathematics ("my mathematics was very good, I chose mathematics"). In this sense, she is suggesting the experience of attending an 'intelligent/Tizhoshan school' and success in the Konkur acts as a form of cultural capital which, alongside the social capital offered by her relationship with her brother who is doing a PhD in mathematics, has enabled her to access mathematics. Mona's account here contrasts with the view of some of the survey respondents (see above, Table 8) who reported that they had chosen mathematics because they had not achieved high enough grades for engineering. Mona has achieved what she perceives to be 'high grades' but opts to study mathematics because she 'likes' the subject.

> *I: Tell me about your past? How did you come to study this subject at this university?*
> *M: I had studied in an intelligent (Tizhoshan) school and my university's grade was very good, then as my brother was a mathematics PhD student and I liked mathematics and my mathematics was very good I chose mathematics.*

However, in the quote below Mona appears to lament her decision to choose mathematics and aligns herself with the notion that engineering as a subject has higher status and better job prospects whereas "mathematics doesn't have a future". She describes her decision to choose mathematics as "ruining her good opportunity", which I interpret to mean the opportunity afforded to her by achieving a high grade in the Konkur. As a result, she self-authors her choice of mathematics based on a mathematical identity statement "I like mathematics" but juxtaposes this with "being

more successful" and being able to "do a better job" which she believes would have happened had she opted for architecture[12].

> *I: Tell me about your life story, what were the difficulties and opportunities that you faced so far?*
> *M: Well, my good grade [in the Konkur] was one of the good opportunities, but my choice of mathematics has ruined it, it is a subject which doesn't have a future.*
> *I: So, you regret that you had chosen it?*
> *M: I cannot say I regret it, I like mathematics, but I would be more successful if I studied architecture, I could do better job now.*

Furthermore, in the quote below, Mona states that one of the reasons that many students choose mathematics is because they "don't get enough score for their interested subject" or, in other words, they end up studying this subject as a secondary option. Interestingly, she uses the term "basic science" in the quote in order to show that all basic science courses (which include mathematics, statistics, chemistry and physics) possess lower status when compared with technical courses which are seen as more advanced. This positioning of mathematics concurs with the survey responses (as mentioned above) and appears to suggest a shared cultural model of mathematics as academically lower-ranked. However, from Mona's point of view, the lower rank/lower status of mathematics does not mean that it is an easy subject and and she highlights how students who are not interested "cannot study the subject". Thus, the 'other' students (who end up studying mathematics as a secondary option) are constructed as a symbolic figure in her story which she dis-identifies with. Arguably, she draws on the cultural model of 'mathematics as hard' in order to convey the 'basic' status of mathematics as arbitrary or unfounded because 'everything you study is mathematics'. When compared to the quote, there is an interesting contradiction between the cultural models she draws on in her account: here, she gives status to mathematics as 'hard', whilst above she recognises it does not have as much cultural capital as subjects like engineering to be exchanged in the labour market.

[12] The discipline of Architecture is recognised as architecture engineering in Iran but in the UK architecture would not come under engineering.

*I: So, mathematics rank lower than engineering but the fact is mathematics is a hard subject to study?*
*M: Very, because it's a basic science, everything you study is mathematics, it is a mistake to come in without any interest, the entire exam we do it has mathematics in, I think the problem is that all students study for Konkur (national exam) and when they don't get enough score for their interested subject they choose basic science (mathematics), meaning that after engineering everybody has the choice of basic sciences on their list of courses, and mathematics is a very difficult subject and if you are not interested you cannot study it.*

Below Mona goes on to discuss the capital that engineering offers students in the labour market by discussing the job opportunities that the different degrees offer. She describes teaching as a lower status profession which stems from the lower wages teachers earn. This claim is reflected in Mona's discussion of the different wages for teachers and engineers, "the minimum wage for teacher is six hundreds Toman a month (120 pounds) but engineers earns about two million Toman (400 pounds) a month which is a big difference". Mona sees engineering as an 'in demand' subject and describes it as a prestigious profession because it offers more economic capital when compared with mathematics. Hence she roots the exchange value that engineering offers (cultural capital) in the economic structure in terms of future earning potential (economic capital).

*I: Do you know why in Iran the basic sciences courses are so low?*
*M: Demand for engineering is higher, everybody chooses engineering first, maybe because it is a kind of prestigious profession? Is it money? Is it wages? I don't know, for example in Iran the minimum wage for a teacher is six hundred Toman a month (120 pounds) but engineers earns about two million Toman (400 pounds) a month which is a big difference.*

This cultural model (mathematics holding lower status) was also expressed when she discussed how one of the lecturers had spoken to her and her fellow students by using his authority to identify them as failures ("you are nothing") on the basis of their university entry grades. Although in her recount of this sub-story, the lecturer does not explicitly mention failure, it is implicit when he says that "you are nothing" and draws on their entry grades to validate this. Mona positions herself away from this 2nd person identity (Sfard and Prusak, 1995), asserting that she is from an

academic background (her school type) and had achieved a good grade in the national exam. Thus, she dis-identifies herself from the position the lecturer constructs in her FW of being a mathematics student. However, despite dis-identifying from this 2nd person identity, the use of 'you' in "you feel that you don't want to be there any more" and "you don't want to continue your studying" to relate to her and her fellow students on the course arguably suggests some internalisation of the negative position constructed by the lecturer.

> *For example, at the beginning of the term we came here with lots of enthusiasm, I come from the intelligent background (Tizhoshan School) and for the first day the lecturer came and told us well what is your university's grades? Do you know what my university's grade was? I ranked 70 when I came to university. He ruined everybody's self-confidence, and he said you are nothing and only me who is the best in here. I don't know many lecturers who are good but many of them really hurt students, you feel that you don't want to be there anymore and you don't want to continue your studying.*

In discussing her future career aspirations below, Mona talks about passing an entry exam and working as a stockbroker in Iran (Tehran presumably) but also wants to continue studying mathematics in order to have a stable future, possibly in teaching. It appears that becoming a stockbroker addresses her problem outlined above: that she chose mathematics because she enjoyed the subject but it does not offer her sufficient capital for the labour market. This sense of a resolution to her contradiction is evident where she comments "they don't bother...what kind of career you have" and "the only thing you need to do is to pass the exam". However, she plans to undertake this career alongside further studying which can lead to teaching – being a stockbroker is juxtaposed with 'a good stable career'[13].

> *I: Tell me about you future desires? Where do you see yourself in 5 years' time?*
> *M: I would like to take an entry exam for the labour and capital market which is called share stock market, if I will be accepted I can work there as one of their employees and start working for share company, they don't bother whether you are a student or not, or what kind of career you have, the only thing you need to do is to*

[13] In Iran, stockbroking is viewed as a risky career as it dependent on the economy which is highly unstable.

*pass the exam, I would like to work there but I want to continue my studies as well. In future, I want to have a good stable career and beside that I can teach as well.*

Like many of the students I interviewed, Mona expressed a wish to move abroad in the future and, in discussing this, she makes comments which seem to recognise that the low status of mathematics is specific to Iran and that the subject is not seen in the same way in the USA (see below). Below, she comments "they really appreciate basic science (mathematics)" and "a teacher has a high status there", information which she has acquired from her cousin who lives in the USA already. Furthermore, she also refers to the figure of a "lecturer in the USA" to align herself with teaching mathematics there. This figure (presumably introduced in conversations with her cousin) appears to "appreciate my study", suggesting s/he recognises Mona's mathematics degree as having capital for the labour market ("I would ask her to be TA and I would give her 1500 every month"). She then juxtaposes this figure with "our lecturers" who "tell us we don't care about basic sciences" because the majority of students have opted to take this subject due to low entry grades.

*I: Why do you want to move abroad (apart from your fiancé's problem with university)?*
*M: Because I know they really appreciate basic science, a teacher has a high status there, when I see such a thing I become glad, when my cousin (who lives in USA) told me about it I started to read IELTS and wanted to take the exam, in fact it could have happened because it wasn't far away from the imagination, I could have done it easily, when I see the lecturer who hasn't seen me so far and even doesn't know my university's average... appreciate my study, I become very happy, he told my cousin if she come here I would ask her to be TA and I would give her 1500$ every month, when I notice they get excited of my study I become very glad, in fact they care about the efforts that you do.*
*I: From where did you know that the basic sciences are so important there?*
*M: Our lecturers told us, they tell us that we don't care about basic sciences but they do, it is true, when you see their choice of degree at university there is a small number of students who choose basic sciences, but in here the majority of students choose basic sciences because their university's grades are low.*

To summarise, in Mona's story it is clear that she perceives other subjects (such as architecture or engineering) have more capital when compared with mathematics

because of its value in the labour market, which is linked to the wider economic structure. In narrating this cultural model, there is a sense in which Mona tries to show her awareness of what she is missing out on by choosing mathematics instead of engineering. When she compares herself with her classmates, she sees herself as someone who is different because of her good grade in the national exam and her intelligent background (school type). Therefore, Mona positions these experiences as demonstrating her embodiment of cultural capital as located in her personal history and she uses such capital to reject being positioned as a failure by others in her narrative. Yet, such rejection challenges the structural positions enacted in the field of Iranian HE which locates engineering programmes as higher than mathematics, so that, whilst Mona can reject the judgement of a mathematics lecturer (using her background), she recognises that studying mathematics limits the extent to which she can exchange such capital in the labour market. Thus, there is a sense of struggle between her interest in the subject and its exchange value, and she therefore reports feeling disheartened from studying mathematics. In order to move away from such negative positioning, she discusses the option of moving abroad to pursue her aspiration of teaching mathematics because in the USA "they value mathematics". In this way, she intends to transpose the 'limited' capital she has in Iran (as a mathematics graduate) to another field, HE in the USA, which will allow her to exchange qualifications for a teaching role and associated economic capital. In Chapter 8, I discuss this process of transposability of capital, where the topic of 'moving abroad' is discussed further.

### 7.3.3 Maryam's Story

Mona's story above and that of Zahra indicates the challenge or struggle to maintain a mathematical identity in a field where other subjects such as engineering hold more capital. The perception that engineering holds capital which can be exchanged in the labour market therefore is a common theme in both accounts. To investigate this further, I now consider the narratives of two engineering students, Maryam and Hiva, to explore whether they see engineering as a form of capital and how they position their own identities as engineers in relation to this.

As evident in the quote below, Maryam told me that, when she was in high school, she was hesitant to choose between experimental science and mathematical science[14] but preferred to study mathematics in order to become an engineer, since this was easier to access than medicine. Her storying of herself as becoming an engineer here is therefore resourced by her performance in mathematics and physics ("my physics and mathematics was better"), and she positions this against not being "studious" enough for medicine. Thus, her choice of engineering is about having sufficient capital (performance) to exchange in a more extensive market (more universities offer engineering).

> *M: When I was at second year in high school... between mathematics and science, I didn't know which one to choose, I had chosen mathematics because it was easier to get into university, I think this was the main reason that I chose engineering and not medicine.*
> *I: Why do you think it was easier to compare with medicine?*
> *M: Medicine has fewer universities, and I wasn't that studious like medicine students study all the time, well my conceptual lessons was better than my memorising lessons, my physics and mathematics was better but I also liked the field of science.*

Like Zahra, Maryam spoke of the influence her family had on her choice of university degree. In the quote below, she reported her interest in the theatre but states that she did not choose to pursue a future in the theatre because her family did not permit this. Therefore, we again see family influence informing the student's choice of degree, which in this case seems to be resourced by a cultural model that cinema and theatre is negatively viewed by others. There are multiple reasons for this: in Iran the relationship between men and women who study or work in cinema/theatre is closer when compared with other environments, and women who work in this environment are afforded a poor reputation in society (i.e. theatre impugns their reputation). The phrase "they want me to study academically, they told me that if you put your life in cinema it's not guaranteed that you would find a job after" indicates the positioning offered to Maryam by her family which is linked to the labour market, but is also likely to be substantiated by the poor status that working or studying cinema has in society. In any case, Maryam juxtaposes her

[14] These are particular 'tracks' or 'pathways' that students might choose when they enter to secondary school.

family's view of studying/working in cinema/theatre with what they see as 'academic' which is the position she then adopts ('I like medical engineering').

Like the students who responded to the survey, Maryam reports the influence of her family on her choice of subject and, in this case, we can see this is motivated by the exchange value EE offers as an academic subject in relation to the theatre.

> *I: Why do you think that your family disagreed with you studying art and theatre?*
> *M: They didn't accept the environment of cinema and theatre, I even wanted to be a director and go into cinema when I was at first year in high school, but they disagreed. Cinema doesn't have a good environment; they want me to study academically. They told me that if you put your life in cinema it's not guaranteed that you would find a job after. I liked medical engineering as well but I didn't get a high enough score for it, and I could have chosen mechanical engineering but I wasn't interested in.*

The influence of other people in choosing EE seems a strong component of Maryam's story, as is evident in the quote below. She speaks of advice from acquaintances who live in Germany and Canada who have told her that EE is one of the popular subjects in these countries and thus will enable her to move abroad (a key aspiration in her account). Thus, I argue here that these others as a mean of social capital are key in mediating her future imagined identity as a successful woman abroad (i.e. they suggest a possible position which Maryam can take up in the future). Again, in the quote below, Maryam presents EE as capital which has exchange value in terms of moving abroad and leaving Iran. The students' aspirations to move abroad is discussed in more detail in chapter 8, but here it is worth noting how Maryam presents EE as offering capital as an 'in demand' subject outside of Iran. Thus, what is seen as high status in this context is viewed as offering the means to bring about some sense of mobility or opportunities which may not be attainable without this capital. Moreover, it is interesting to note how Maryam implicates her gender in accessing such opportunities - she appears to see this also as offering capital in terms of gaining employment abroad: "women can easily work in it and other countries also value it".

*M: Through the research I did, I found out that fields such as EE are more easily accepted by other countries, and as I want to go abroad it was important to me that I could easily go there.*
*I: Why do you think is like that?*
*M: Our acquaintances in Germany and Canada told me, their work is assisting with applying for places at universities for Iranian students. EE is one of the subjects that women can easily work in and other countries also value it.*

The dialogue below neatly captures the perception (or rather cultural model) that EE is a high status subject in this context. It is seen as "difficult" and, as such, "the first in the mathematics branch... a top subject", indicating that EE offers the highest value for those who have elected to study mathematics at high school. Thus, her storying of herself as an EE student is resourced by the status of this subject, which gives her a badge of 'cleverness' which she uses as an exchange value by studying EE.

*I: What do your family and friends think about your subject?*
*M: That this a difficult subject and it is the first in the mathematics branch, a lot of people think this is a top subject.*

Additionally, like some of the respondents in the survey, Maryam speaks in the excerpt below of her interest in mathematics and physics, but that she has no interest in EE ("it wasn't my interest"). Whilst she presents mathematics as "attractive for me", she finds the use of mathematics in EE as not that interesting (by saying "branches", she means those degrees programmes which apply mathematics like engineering). Therefore, given what Maryam has told us above about the status of EE as a form of capital, we can conclude that, despite having no interest in EE, she chooses this degree programme because she believes it can bring about a better future (moving abroad and becoming a successful woman). This suggests that the cultural model that EE is a top subject is drawn on to narrate its exchange value within the interviews and, on this occasion at least, it is also juxtaposed with any 'interest' it offers to Maryam (which presumably is not as important as getting a good job abroad).

*I: So, you choose this subject because you want to move abroad?*
*M: Yeah, this was the main reason.*
*I: It wasn't your interest?*

*M: No, it wasn't my interest, I like mathematics more, mathematics itself was attractive for me but its branches weren't really my favourite, using mathematics or physics in EE isn't that interesting.*

From Maryam's story, we can notice that she does seem to have a particular identity or relationship with mathematics and dis-identifies from EE saying she is not interested, which is juxtaposed with a future imagined identity as an EE abroad. However, she is inclined to continue her education in engineering as she aligns with the cultural model of engineering holding capital in the graduate labour market. Therefore, as with mathematics in Mona's story, studying EE in Maryam's story appears to offer transposable capital which helps her finds an easier way to achieve her future goals.

### 7.3.4 Hiva's Story

Hiva is an EE student and she is in her second year of study. Hiva has been interested in art since she was a teenager and playing in the theatre was a key interest at university (she was involved in various underground theatre productions, one of which she invited me to). However, despite this strong desire, she did not choose to study art at high school. As she states in the excerpt below, "I did not even dare to say it", which indicates her perception that wanting to study art would produce a negative reaction from her family which she did not want to experience.

The pathway she chose in high school was mathematics, mainly because of her own interest in the subject and her father's encouragement for her to become an engineer. The dialogue below shows that, like some of the students in the survey, her choice of EE is shaped by her family's positioning of her: "my family told me to choose science" and "he told me you can be an engineer". Here, we might argue that there is more evidence of the practice referred to in Chapter 6 in relation to Zahra's story, whereby family members each have an input into the decision regarding choice of degree. In this case, it is Hiva's father who is the main focus of this practice: he acts as an important figure in the story who directly influences her identity as an EE student. However, unlike Maryam's case above, the choice Hiva makes here is not straightforward, since Hiva self-authors her engineering identity as an integration of

both her father's influence (“be an engineer and learn art as well”) and her own interest in mathematics (“I really like mathematics”).

> *When I was at first year in high school, the time that I needed to choose my path throughout university, that time I was good in mathematics, first my father and my family told me to choose science to become a doctor, but I really hated it, I liked to study art but I didn't even dare to say it, once I told my father, he told me that you can be an engineer and learn art as well. I liked humanities as well because of my friends but I really like mathematics.*

A dominant part of Hiva's story is her opinion that art and engineering do not necessarily conflict, since she believes that engineering structures people’s minds and doing art requires a structured mind. Arguably, this belief allows her to align herself with her father's opinion of an appropriate degree choice, yet she draws on a less typical cultural model about EE as creative: “I feel now that engineering is closer to art”. This is less typical in that it was not discussed in the survey or by other participants in the study, yet it remains a cultural model because, arguably, it draws on a cultural model that mathematical subjects (including EE) are creative and imaginative. Therefore, her belief is that EE and art are in harmony with each other, whereas Maryam presents them as juxtaposed (she could not pursue her interest in theatre/cinema and become an engineer). What marks these two accounts as different appears to be the influence of ‘my family’ and in Hiva’s case her ‘father’. Whereas Maryam’s family are perceived as not permitting her interest in the theatre, Hiva tells that her father has encouraged her to purse ‘arts’ alongside her degree in EE. Thus, in discussing choice of degree, we have more or less agency afforded by ‘family’ to each participant, which then appears to be associated with the amount of ownership they each have over their EE identity. For instance, Hiva states that engineering has “structured her mind”, whereas Maryam identifies engineering as not really of interest to her.

> *My mathematical thinking is really useful for doing art activity. It's not only me who is like that, I have seen many like this. In fact those who engage with mathematics have a more structured mind and have a broader view towards art. I know a guy in here who I can tell is a genius, the robotic system is totally under his hand and*

*he follows music somehow differently to others. I didn't know this before but I knew if I studied engineering I would have a better structured mind. But I feel now that engineering is closer to art.*

Like Maryam, Hiva also declared that her preference for EE was influenced by the status of the subject. Thus, in the quote below, she aligns herself with a cultural model of EE as a prestigious subject which we have seen before (see below - "it's very prestigious.. it has a social status in Iran"). This directly relates to my earlier argument about EE having status or capital, as it almost gives students a badge of cleverness. She even talks about others only choosing EE for its name: "the name plays a significant role on choosing this course, when I look at my friends I can see only one of them who love the subject". But Hiva also seems to be using this capital to hide her pursuit of the theatre despite her comment above, where her father says she can learn art alongside engineering. Here, her pursuit of the theatre is presented as not socially acceptable to her family ("they don't know that I spend 99% of my time in the theatre"). Therefore, she consciously subverts the status that EE offers (i.e. it keeps my family happy) as a means to hide the work she is doing in the theatre ("on Wednesday I come to university only for theatre").

*I: What do your family think about your course? What about your friends?*
*H: They think that I am very studious and know everything but they don't know that I spend 99% of my time in theatre; I don't have class on Wednesday but I come to university only for theatre.*
*I: What do they think of your course?*
*H: They think it is for crazy people, it is very prestigious, so it's like the number one to ten of the national exam sat all in the class together and try to unravel the atomic nucleus, I don't lie if I say that I had chosen it because of its prestigious status, it has a social status in Iran.*

However, studying EE whilst at the same time pursuing the theatre in secret from her family does not come without troubles. Below, Hiva talks about arguments with her Mum and her family because they do not see her theatre work as appropriate for their daughter. As a result, Hiva appears to be resisting her family's negative perceptions and their positioning of her as deviant in some way: "..at least try to understand me....I didn't really accept such behaviour". In addition, she resists a cultural model narrated in her mother's positioning of her which sees art/theatre in terms of time-wasting by saying that "she told me no one is like you spend her life

on these kinds of stuff". Note here that it is her mother who is implicated in this sub-story rather than her father, who above appears to support her interest in art.

> *One of the things that bother me is about arguing with my Mum and my family all the time, I want to go out but they don't let me. But these are ordinary arguments, they don't understand that I like art, they don't support me at all. Once I was an executive in a show and my Mum was telling me off and she told me 'no one is like you, spending her life on this kind of stuff', that made me sad and I cried a lot, because 'at least try to understand me', maybe many parents are like that but I didn't really accept such behaviour.*

So, whilst it may appear on the surface that Hiva is able to align her interest in art and engineering (which pleases her father), her pursuit of the theatre seems to be in conflict with her identity of being a good daughter (at least in relation to her mother). This tension between the theatre and pursuing a career in engineering is further complicated by what she perceives as discrimination against woman in engineering. In the extract below, Hiva reports her sister had planned to open a private industrial company with her friend but their work was not of interest to others because of their gender. This is an interesting tension here: although her family and Iranian society perceives engineering as prestigious (hence higher entry grades), Hiva perceives that women are not in a position to become successful engineers in the labour market by saying that "women do not fulfill their promise". Thus, Hiva appears to be criticising the capital that engineering offers women like her. As a result, we can conclude that her engineer identity (in the present) involves conflict which she will need to negotiate in the future in order to overcome such gender discrimination. This can be juxtaposed with Maryam who believe EE will allow her to become a successful woman, even if that means exchanging its capital in the international labour market, rather than in Iran.

> *My sister was studying industrial engineering, she was working for a company and she was a good worker. Once she decided to open her company with her friend, I know that they faced a lot of problems, no one accepted them. In general I have been confronted with many cases where women do not fulfil their promise, but I never say this because I am a woman but if I were a man I would probably say it.*

From Hiva's story we can conclude that, like Maryam, she recognises the exchange value or capital that studying EE offers. However, she also appears to recognise this status as somewhat arbitrary - it allows her to hide her 'love' of the theatre to some extent and it can enable her to fulfil her father's wishes. In this sense, I argue that Hiva recognises the arbitrary game of capital exchange for what it is (e.g. recognising that women do not fulfil their promise) and subverts it to her own interests. Nevertheless, this narrative is not without struggles, as Hiva speaks of several conflicts with family which relate to her love of theatre. Thus, there seems to be a conflict evident in Hiva's narration of her engineering identity and the integration of arts/theatre. She attempts to subvert the capital it offers (to hide her theatre work) but this clearly does not fully work and she is 'othered' by her mother who states that 'no one is like you'.

## 7.4 Comparison of Mona's, Maryam's and Hiva's Narratives

This section explains how this chapter answers the RQs which are related to the forms of capital evident in the narratives (RQ1) and the positional identities discussed by my participants (RQ2). In all three narratives, we see engineering being referred to as offering status or prestige which I have conceptualised as a form of cultural capital which can be exchanged for further capital. In Mona's case, we see her identify a perceived deficit in her own capital in terms of accessing the labour market because she has chosen to study mathematics over engineering. The extent to which this deficit exists objectively is unclear since, as Hiva notes, many women with engineering degrees face discrimination in the labour market. Nevertheless, Mona does appear to recognise the prestige and status of engineering which was also supported by the participants' open responses in the survey. In Maryam's case, I have highlighted her alignment with this cultural model of prestige attached to her EE degree and, in Hiva's case, I have argued that she subverts the arbitrary nature of such capital through her hidden work in the theatre. Therefore, this form of capital is drawn on in their account of choosing engineering which, arguably, gives them some autonomy to exert agency over their future life trajectory.

In relation to RQ2a, all three students appear to narrate an identity which is positional in relation to the capital engineering offers but which is also relatively conflicted. Mona expresses her mathematical identity as one of 'love' for the subject, but this conflict with her future imagined identity of becoming successful in the labour market. Hence, her recognition that she lacks capital because she studies mathematics and not engineering serves to produce this fragility. On the other hand, Maryam realises her EE degree offers her opportunities and thus identifies with the position it affords as a form of capital. Yet again, there is a sense of conflict in her account, since her future imagined identity of becoming a successful woman requires a move away from Iran (I discuss this fragility further in Chapter 8). Finally, in Hiva's account, I have highlighted how she uses EE to hide her underground theatre work from her family, but the success of this strategy is unclear since she reports many conflicts which indicate troubles that she must overcome. For instance, she has chosen engineering to please her family, but her underground theatre work does not fit her notion of a 'good daughter'. This conflict is also manifest in her observation that engineering offers high status but the gender discrimination in engineering (not sure to be a successful woman in engineering) presents a lack of opportunity in this respect (the glass ceiling). Therefore, Hiva's future is becoming less clear for her and her engineering identity seems more conflicted when compared with Maryam who has a definite plan of using her degree abroad.

Another similarity evident in these stories is the love of mathematics which is a common theme across all three narratives. For Maryam and Hiva, this mathematical identity led them to choose engineering and so it resources their engineering identity and their sense of entitlement. But, for Mona, her mathematics identity has caused problems for her since it means she does not exchange her high academic grades for a degree which has exchange value in the graduate labour market and she is positioned quite negatively by her lecturer. Thus, the exchange value of her mathematics degree in Iran is a career in teaching which is a relatively lower paid career compared with engineering. She also talks about becoming a stock broker but this does not depend on the exchange value of her mathematics degree as "they don't bother...what kind of career you have" and "the only thing you need to do is to pass the exam". Therefore, this gives her a negative identification towards mathematics

and awareness of what she is missing out on by choosing mathematics over engineering.

## 7.5 Conclusion

In this chapter, I have sought to use three narratives to illustrate how engineering affords students capital because, theoretically speaking, it can be exchanged for a high paid career. However, whilst subscribing to this idea, the interviewees also state that such capital is not easy to exchange as a woman in the labour market in Iran, and thus there is a contradiction which mirrors the evidence discussed in Chapter 2: that there are increasing numbers of highly-educated women in STEM but far fewer are employed in 'Industry' or STEM-related careers. In the next chapter, I move on to discuss how some of the women spoke of their aspirations for the future as involving a move abroad.

# Chapter 8: Moving abroad

## 8.1 Introduction

In this chapter, I focus specifically on the aspiration to ‘move abroad’ which emerged as a dominant theme across the women's narratives. In the previous chapter, I established that EE is seen as a prestigious subject which is given symbolic value (capital) by the students but also their families, teachers etc. Arguably, this prestige (as a form of capital) is different to how engineering is seen in some western contexts and, thereby, is a manifestation of the particular cultural, historical and economic Iranian context. I discuss this ‘local’ form of capital and its role in mediating mathematical and engineering identities further in Chapter 9. This chapter discusses how the women narrate an imagined exchange of capital by discussing their use of their engineering degree as a means to move abroad or leave Iran. By focusing on this theme, I aim to establish how the ‘local’ Iranian field of HE and employment is situated in a more globalised context, where capital holds value across (rather than within) localities. This addresses RQ1 which asks: How are the cultural-historical-economic structures and conditions of Iran manifest in Iranian female STEM students’ narratives regarding their choices, experiences and aspirations?

Furthermore, I also investigate how my participants express a sense of agency over their imagined future and how they frame this in relation to ideas about gender determinism which they suggest are dominant in Iran. Here, I will argue that 'moving abroad' also acts as a cultural model which some of my participants draw on to identify themselves as successful women in a global context using their degree as capital. However, I also discuss cases where my participants disassociated themselves from this cultural model, which I argue also expresses a sense of agency over their future. In making this argument, it is important to recognise how these women’s narratives are mediated by their class position in the Iranian context. This argument therefore addresses RQ2: How do Iranian female STEM students position themselves in relation to such contextual conditions?

The data reported here focuses particularly on five of the female students interviewed who talked about their aspiration to move abroad[15]. In this context, moving abroad is used with two meanings (or two associated story types): firstly, it refers to leaving Iran temporarily for studying; and secondly, it refers to leaving Iran to work and live abroad more permanently.

In the text below, first I re-visit the narratives of two EE students discussed in Chapter 7 (Maryam and Hiva) and present the narrative of Shieda, a computer engineering student, in order to show how 'moving abroad' is positioned as being about an exchange of capital (their engineering degree) for a 'better future' (escaping from Iran). Second, I present two narratives of Computer Engineering students, Sarah and Yalda, who provide a contrastive account in that moving abroad does not necessarily involve 'escape'. Nevertheless, I maintain that, for both groups, their degree programmes are arguably viewed as providing capital which can generate capital growth in different ways.

Furthermore, my analysis of both these 'story' types highlights how issues of gender discrimination are present. Some perceive such discrimination as a barrier to their future progression (to overcome by moving abroad), whilst others do not appear to recognise this as an insurmountable barrier (hence their willingness to return to Iran). Such perceptions also appear to be somewhat related to various forms of positioning by family members, with those wishing to escape Iran resisting parental pressures. In contrast, those who want to move abroad and then return to Iran draw on the support of allies (e.g. supportive fathers) as a means to further their own personal development, or in an effort to change Iranian society (along with patterns of gender discrimination).

Therefore, in the final section of this chapter, I highlight how the roles of others in the students' narratives are crucial in enabling them to imagine a future abroad in various ways. Whilst some of the students either resist or align with how they are positioned by others (i.e. parents), many also discuss others (e.g. siblings/acquaintances) who are already planning a move abroad or already living

[15] There are two other students who discussed moving abroad (Zahra and Mona) and their data has been analysed in the previous chapter.

abroad. I suggest these others operate as a form of social capital since they offer knowledge, insights, support in moving abroad (cultural capital), and, perhaps more importantly, allow the students to imagine themselves in similar situations. This chapter should be viewed in relation to the issue regarding the apparent 'brain drain' from Iran.

## 8.2 Students Using Their Degree to Escape from Iran

The first group of students I identify below contains those who explicitly discussed barriers to their success and progression in Iran. These students seemed to be imagining a new figured world in working abroad, which offered them an escape from such barriers. Through my analysis, I argue that these students use their degree programmes as a form of capital which, because it holds value in other fields, offered a means of escape.

### 8.2.1 Re-visiting Maryam: EE as Transposable Capital

In Chapter 7, I presented Maryam as someone who aspires to use the capital that a degree in EE offers her to move out of Iran and to pursue an engineering career abroad, despite her interest in Art and Cinema which she was not allowed to pursue.

The idea of escaping appeared to be a dominant theme in her story and she clearly stated that, if she leaves Iran in the future, she would not wish to come back. In the quote below, Maryam presents this position very clearly by juxtaposing "helping the Iranian people" with her own "welfare" which she prioritises as "a selfish person". She talks about Iran as a place where she cannot progress, which corresponds with her assertion that anyone who comes back to Iran (from abroad) needs "big motivation" because this means serving others rather than oneself. From her point of view, coming back to Iran carries a responsibility which is to use knowledge to help people or to make Iran a better place to live. As I note later, this seems to be a cultural model that several of the students draw on in different ways (i.e. coming back to Iran involves helping people). Here, Maryam dis-identifies with this cultural

model, stating that others who come back to Iran are more philanthropic people who put others first.

The quote also highlights how Maryam narrates resistance to her father's positioning of her as someone who might "go and come back ...to help Iranian people". Thus, she mis-aligns herself with the idea that her family/father should be involved in her decision-making (a cultural model I identified in Chapter 6**).** So, here Maryam's imagining of a future which involves living abroad is resourced by her dis-identification with the cultural model of family involvement in decision-making.

> *I have always thought that Iran is not the place for me to live and to progress. In my opinion staying in Iran needs motivation and I don't have that motivation, my father is always telling me to go and come back and to help Iranian people, but coming back to Iran needs big motivation, anyone who's serving their people as a priority could come back, but I'm not like that, I am a kind of selfish person who prioritises her welfare first, if I wasn't into my own welfare I couldn't help anyone.*

In Chapter 7, I noted how Maryam recognised that she could use her engineering degree as capital in the international labour market, particularly in countries such as Germany and the USA. In the exchange below, she discusses the gendered nature of the Iranian labour market more explicitly in response to my question on the topic:

> *I: Do you think in general it is easy for women to enter in to the labour market?*
> *M: Its not very easy, they have to try it, for example in courses like mine [EE], they might able to get a job but they might not get the same wage as a man.*

As such, here we see she believes it is possible for women to gain employment in engineering in Iran, but this means earning less which does not meet her aspiration to become a successful career woman which, as shown in Chapter 7, can only be realised by 'moving abroad'.

As noted in Chapter 7 and in the quote below, in self-authoring her decision to move abroad she speaks of two countries: Germany and the USA. Here, I argue that Maryam sees her future self in two different imaginary worlds in becoming an EE.

Firstly, the imaginary world of living in the USA which involves having family nearby, already being able to speak the English language, and paying university fees (presumably for postgraduate study). This reference to “some family” here refers to others who occupy this FW who then resource her imagined identity as one of 'belonging' there. Secondly, the imaginary world of living in Germany includes issues such as not paying universities fees and having a “good opportunity for my subject” due to the industrial economy. By comparing these two countries, the global economic context is again implicated in constructing her identity as an engineer, and she speaks again of her potential capital growth in the form of “better opportunities” without having to pay any university fees.

> *USA is the first choice because if I go to the USA I don’t need to learn another language and I have some family there and it is not very expensive when compared with European countries. But the bad thing is that universities are charging fees, Germany is an industrial country which is good for my subject and many universities are free but the bad thing is that I have to learn German.*

Therefore, I argue that a degree programme in EE is positioned in Maryam’s story as offering transposable capital which helps her find an easier way to achieve her future goals of being a successful woman. She states that moving abroad would be permanent, and in self-authoring her decision to do so she talks about lack of progress in Iran and a better future in the USA or Germany. Thus, for her, studying EE abroad is an improvisation which can enable her to continue to generate capital in the form of a relevant career and becoming a successful woman which might not otherwise be accessible in Iran. However, this imagined future also implicates relations with others who can potentially resource this exchange of capital (i.e. they provide social capital). For instance, in Chapter 7, I note how she aligns with the figure of 'her acquaintances' who recruit Iranian engineers in Canada and Germany, and in this chapter she refers to her 'family' in the US who then resource her imagined future identity as an engineer.

### 8.2.2 Re-visiting Hiva: EE as Capital + Identity

In Chapter 7, I have illustrated how Hiva uses EE as capital to pursue her underground work in theatre. She reports she is in love with theatre but, because of the negative perception of theatre in society, she has chosen EE instead. She has also reported conflict with her mother who does not approve of her theatre work, but appears to be more affiliated with her father who has persuaded her to study EE as a way to pursue her interest in the Arts. In this section, I discuss how she narrates her future aspirations in terms of moving abroad.

In Hiva's account, moving abroad is not just part of her imagined future but it is something she already has direct experience of. She had already moved to Cyprus but regretted this move after a short period of time and moved back to Iran. Yet, despite this, when I asked Hiva about her future, she talked about working as an engineer and moving abroad once again (particularly to Canada). In the quote below, she points out that she "has many reasons for leaving" and, in the subsequent dialogue, she names some of these. Although she has made up her mind to leave Iran, whether she stays away permanently is unclear. Again her dialogue seems conflicted and, as I suggest below, this confusion is mainly derived from her simultaneous desire to have a different life than what she perceives may be the case in Iran, but also her need to be loyal to family and friends. Here, we can argue that the figures of family and friends are influential on her decision to both move abroad and come back to Iran later in life. For instance, the figure of her sister seems an important ally in imagining a future in Canada: "my sister is leaving Iran in one year's time to go to Canada, if my sister goes I will go there as well". There are many comments throughout the interview where she aligns with her sister in her story and her sister seems particularly important in resourcing her identity as future successful women. On this occasion, her sister as an ally/role model gives Hiva an opportunity to think about moving abroad and resources her notion of what becoming an engineer might be like outside of Iran (her sister is an engineer and, in the previous chapter, I highlighted how Hiva talked about her sister facing gender discrimination in labour market). This reference to "family loyalty" here is interesting given the conflict she reports in Chapter 7: the juxtaposition of "family loyalty" with the figure of her sister as ally suggests that this decision is one of struggle.

> *I have to decide certain things which depend a lot on this summer, I want to work as an internship this summer at my father's friends company and learn technical stuff. So if I feel interested I will continue it [EE]. The chance that I will leave Iran is very high, my sister is leaving Iran in one year's time to go to Canada, if my sister goes I will go there as well, I want to go out of Iran and I have many reasons for my leaving. My family and friends are the only thing that prevents me from going otherwise I am not patriotic, nor thinking about these kind of stuffs.*

In terms of her reasons for moving abroad, Hiva talks about darkness in Iran which does not provide the kind of "free" lifestyle she wishes to pursue. Below, Hiva explains that a "poor culture" "brings darkness", meaning that people interfere in each other's work and she believes that this is a dominant practice in the Middle East. Thus, the 'other' people in the Middle East act as figures in her story which again reflects the conflict I mentioned above. They represent people who she dis-identifies with ("because of these I want to leave Iran") but, at the same time, she appears to see herself as part of 'these people' (e.g. "I don't know why we are like this…"). Nevertheless, I suggest that her feeling of being different from the majority provides a conflict which enables her to think about moving abroad.

In terms of cultural barriers, Hiva talks about limitations on women and prohibition on music and dance which "brings darkness". As a result, we can conclude that her choice to move abroad comes from her need to address the cultural barriers which she has faced so far in pursuing her love of the theatre, arts and music, as outlined in the previous chapter. In fact, resisting these cultural barriers seems crucial to her account, as she states "I think too much about this stuff and because of these I want to leave Iran".

> *Our culture is like that, I don't know why we are like this, for example interfering, I don't know where this comes from, why Middle Eastern people are like that. Why they are curious about what is going on between two people. Let them be free, I think too much about this stuff and because of this I want to leave Iran. People cannot tolerate anyone who disagrees with their opinion, they limit women, they also ban music and dance, all of these forbidden, well, this brings darkness, humans can live without engineering but without art life would be very difficult and the beauty of life has no meaning. It is very difficult not to listen to*

> *music even for a day, now good musicians are working underground and the weaker musicians can get a license to release their album. I know someone who is very good in music but working underground, and because of this the culture of music is getting worse. There is no variety, there is no freedom of thought.*

Moreover, although she says "humans can live without engineering" above, there is a strong sense of an engineering identity in Hiva's story. Below, she describes herself as a person who is always curious about knowing what is going on inside electrical appliances. In terms of her engineering identity, she talks about wanting to go to her father's friend's company to work with electrical instruments: "I have always wanted to get in to the electrical instrument". So, her aspiration to move abroad to become an engineer is not merely about acquiring better opportunities, jobs, etc. (i.e. using her degree as capital), as appears to be the case in Maryam's account, but it also involves being able to do a job she loves.

> *I have always liked to know what is going on inside electrical appliances, now I bought a small book which is explaining what is inside TV, I was always curious to know about electrical instruments, mechanic was the best subject for me but I didn't get it, now I am waiting to go to my father's friend's company to work with electrical instruments as a trainee, God, I have always wanted to get in to the electrical instrument.*

From Hiva's story, we can understand that she sees society as presenting barriers which may prevent her from doing the work she "loves", and because of such a view she imagines leaving Iran.

Arguably, there is also some sense of agency in her story that moving abroad is a form of escape or resistance to Iranian cultural expectations. As I highlighted in the previous chapter, she believes that it is not easy for women to be successful engineers in Iran, and she talks about male stereotypes and her sister who faced gender discrimination in this respect. As such, moving abroad is arguably an improvisation which allows her to circumnavigate gender discrimination in Iran (in the labour market but also in relation to cultural practices such as music and art). This expression of agency, therefore, does not merely involve the exchange the capital (i.e. her EE degree for further capital in the international labour market), it

also enables her to imagine a future which aligns with her engineering identity (i.e. working with electrical instruments). Thus, studying engineering satisfies her inner motivation to create as well as offering a way out.

### 8.2.3 Sheida: Moving Abroad as an Expression of Agency

As noted in Chapter 5, Sheida is a computer software engineering student and, at the time of her interview, she was in her second year of study. Before she decided to study computing Sheida was interested in politics, management, psychology and physics. Sheida had liked politics since she was a child but her parents were not convinced this was a useful choice mainly because of "the lack of job opportunities" in this respect. Due to her family's disapproval lack of approval she decided to choose mathematics at secondary school and later she chose computing at university.

> *The first year in mathematics was good, but in the second and third year I hated my field, I always told myself that I wish I had never chosen this field, I decided to change but my family insisted on pursuing this field.*

Various different resources and 'other' people are drawn on in her story to support her identity as a computer engineering student. These resources namely are an advisor at high school, personal interest, friends, better job opportunities, and studying abroad. For instance, her school advisor played a major role in Sheida's decision to choose computer engineering by advising her to forget physics (another subject of interest at the time) and choose computing instead, mainly because of the "bad view of physics" and "better job prospects". Sheida reported that choice of degree emerged through recognition of her own competence in computing which she felt was better than in other subjects. Her friends also realised that she is good at computing and they encouraged her to choose this subject at university.

Like the other women I have discussed above, Sheida uses computing as capital to create a better future for herself in her narrative of the future (shown below) as she believes "there are lots of jobs in computing all around the world".

> *Computer engineering is among the best, it has a good income as well as having lots of job opportunities all around the world, and I generally like it.*

Thus, by studying computing she can fulfil her desire of finding a job and living abroad. She would like to be a manager of *Google* or *Apple* in the future, however in the next five years she aims to study and work in Canada. Although her long term future aspirations are highly ambitious, she believes that "people should have big ambitions in order to reach a higher position". She particularly emphasised her financial independence and being a director of a company as important goals for her future. The extent to which she sees computer engineering as a form of capital is evident in the quote below where she highlights the status of the subject which attracts students who are 'more intelligent' than others.

> *I: what does your family think about your subject? What about your friends?*
> *S: Basically, my friends think that those studying computer engineering are more intelligent than others; there is such a view towards computing, because they say that computing includes programming which is not easy, it needs a very organised mind, step by step you need to put your time in to it, as well as this it needs a bit of mathematics.*

However, 'moving abroad' also plays a slightly different role in Sheida's narrative, since it emerges as a product of wanting to resist family expectations. Her narratives contain several sub-stories regarding family conflict in relation to her choice of degree subject and it appears that 'moving abroad' allows her to comply with their expectations whilst still expressing her own agency. For instance, in the quote below, Shieda recounts how she disliked studying mathematics in secondary school secondary school (age 14-17) and had decided to change track towards Psychology or Management (recall that Iranian secondary school students choose a particular subject area - humanities, basic sciences, medicine - which influences the path they can take via the Konkur and into university). However, her family had insisted that she remain studying in the field of mathematics, and she presents this imposition as her reason for moving abroad ("I said ok I will study mathematics but I will apply for abroad universities later"). In this sense, the family's disagreement with her decision to drop mathematics (change track) becomes a tool which resources her aspiration in the account and thus it helps her to express some agency or control over her own future. She appears to see 'moving abroad' as an act of resistance to her family and, therefore, dis-identifies from the cultural model that family should have an input to their daughters' choice of degree (see Chapter 6).

However this is not an act of straightforward dis-identification, since Sheida also articulates that she feels the need to persuade her father (by taking the IELTS exam and preparing) and therefore receive his approval. It is a matter of negotiating her own future within the confines of her father's approval. Throughout her narrative, Sheida appears to be constantly trying to negotiate resistance to her father's dominant position in their relationship and his power to determine what course she should take. So, although going abroad is not totally forbidden by her father ("my father told me... if you won't accept this then go"), it seems she recognises him as a significant figure in mediating her choice.

> *The first year in mathematics was good, but in the second and third year I hated my field, because I said that I am the kind of person who should study humanities like psychology or management. I always told myself that I wish I had never chosen this field. I decided with my friend to change our subject in the last year of secondary school but my family insisted on pursuing this field. Then I said 'I will apply for abroad universities, from the third year at secondary school I have decided to go', I said 'ok I will study mathematics but I will apply for abroad universities later'. I had prepared everything for my going, I even took the IELTS exam. Everything was ready and then it was near to my university exam that my father told me'you better stay in Iran and maybe you will be accepted in to a good university. If you stay here it is better' 'If you wouldn't accept then go'. This caused me to stay, then I took the national exam [Konkur]. After the national exam I still wanted to go, but I saw that I have the grades to come to this university and study a subject that I like [computer engineering]. Then I said 'after my graduation I will go'.*

But Sheida also recognises a sense of injustice in the way her father shapes her decision-making. In the quote below, she states that whilst her father supports her financially due to the fact that he wants her to stay in Iran, her brother is treated very differently**.** In this way, she perceives the injustice of being required to stay in Iran whilst her brother, who has not achieved particularly well in the National Exam, is encouraged to leave (despite not wanting to). Consequently, I argue that she self-authors a resistance to the identity of a dutiful daughter which her father attempts to construct for her (note the storying of his voice in the quote above).

*I: Who is helping you financially? Why?*
*S: Only my parents, my father*
*I: Why do you think your father is helping you?*
*S: I feel he doesn't want me to go; he likes me to stay with him*
*I: Why?*
*S: I don't know, maybe because of the affiliation he has with me, he likes that I stay with him always. He only has two kids, and if one of them goes he is going to be lonely.*
*I: Then your brother wants to go abroad as well?*
*S: No, as a matter of fact my father wanted to send him abroad but he said that he is not going*
*I: Why did he want to send your brother but not you?*
*S: His results was not very good in the national exam, he didn't get a good result in it. He could only get in to a private university, and since my father gives importance to these things and is totally disagreed with private universities, he asked my brother to go abroad.*

Nevertheless, this relationship with her father is one of complexity as, despite recognition of the injustice of her father's insistence she stays in Iran, Sheida also believes that this insistence stems from her close relationship (affiliation) with him. As a result, this issue can be seen in two ways:1) the love of father for his daughter and a desire to maintain that relationship; and 2) the patriarchal domination of the father who imposes his view on his daughters' trajectory whilst maintaining a different trajectory for her brother. In some sense these two interpretations may act as two sides of the same coin, where love is seen to disguise dominance and gender discrimination. As a result, in the quote below, Sheida describes her family as potentially acting in patriarchal interests because "they let my brother go" which is then connected to others (e.g. her lecturers) who have more fundamental beliefs about female subordination to male dominance in Iranian society more generally ("they like society to be under the hand of men all the time").

*I: Have you ever experienced patriarchy in your life?*
*S: My family are not that traditional to have such an opinion, but maybe because they let my brother go and not me could be seen as a kind of patriarchy. There are some lecturers in this university who see boys as more intelligent, for example in answering a question if a boy and a girl raises their hand up, they normally would ask a boy to answer the question, this is the view that many lecturers have here.*
*I: Why do you think they have such a view?*

> *S: This relates back to the issue that they don't like women to reach high in society, they like society to be under the hand of men all the time.*

In the paragraph below, Sheida again implicates 'moving abroad' as a matter of resisting her family's influence, particularly their financial support. The phrase "I have always told my family that I want to study and work abroad" shows a perception of resisting her father's decision discussed above. 'Being independent' is one of the influential reasons that motivates Sheida here, as she is prepared to leave her family and her country to achieve it and she sees this as a key part of who she is: "It is not my personality to ask for money from anyone". Thus, she is self-authoring her identity as a kind of woman who wants to "be independent" and have her "own income".

> *I have always liked to be independent, have my own income and have my own life. I have always told my family that I want to study and work abroad. If I go abroad, I will be independent and my family won't need to support me financially. It is not my personality to ask for money from anyone.*

Like Hiva and Maryam, in the quote below Sheida states that moving abroad is necessary to overcome the cultural barriers regarding gender discrimination in Iran, which presents a "hard situation for women to find jobs". Therefore, studying computer engineering is seen as an escape route, it offers the capital to 'get a job' in a labour market which does not place as many restrictions on women. As such, by moving abroad she can enact her 'independence' as a form of identification in a way that she sees as not possible in Iran (she uses improvisation in this sense). Thus, her storying of herself as an independent woman and her becoming a computer engineer is resourced by her need to resist the cultural model of non-working women. Moving abroad resolves the contradiction between wanting to "be independent" but facing a "labour market that prioritises men over women".

> *I: Why do you prefer to go abroad?*
> *S: I like to study there [present university] and find a job straight after that, if I stay here [Iran] I will need to take a master's degree and I am not sure whether I will be accepted or not. If not, I have to search for a job in the labour market and I feel they won't recruit me. In the labor market they prioritise men over women,*

*specifically in my field. Many have this ideology that women aren't good workers.*
*I: Why do you think there is such an ideology among Iranian people?*
*S: Because this is a kind of reality about Iranian women due to the fact that they get married and give birth soon afterwards, so they cannot easily return back to the job and for some, their husbands do not allow them to work. There are many things like that in Iran. We are not that civilised yet to realise that married women with children can return back to the labor market, and because of this I don't see myself as staying and working here. I would like to go somewhere where I am sure that I can get a job afterwards, I have always liked to be independent and have my own salary and I don't see these in Iran.*

An analysis of Sheida's story indicates that 'being independent', the difficult situation facing working women in Iran, and patriarchal beliefs in Iranian society are key motives for wanting to move abroad. As a result, she expresses the need to exercise a sense of control over her future, even to the extent of resisting her father's influence. This also suggests a sense of consciousness of the patriarchal norms operating in Iran, whereby she perceives that 'staying' will position her as oppressed by such norms.

Thus, from Sheida's story, I argue that her aspiration to move abroad indicates an attempt to exert a sense of agency which she feels compelled to narrate in her interview. In becoming a computer engineer, she positions herself as an authority in order to challenge the cultural expectations inherent in a patriarchal society. So, at the beginning of this section, when Sheida talks about computer engineering as prestigious (for the more intelligent), she presents it as a form of capital which can be exchanged in a global job market which will then enable her to transcend the gendered cultural barriers which affect her imagined future as an independent woman.

The association between Shieda's resistance to perceived gender discrimination in Iran and her resistance of her family's positioning of her is worth commenting on here. This is similar to Maryam and Hiva, who also spoke about resisting family influences; in the case of Sheida and Maryam this is about their father-daughter relationship, whereas Hiva resists her mother's expectations. What seems noticeable

here is that they each highlight family support for choosing a degree subject which has capital (engineering) but there is rather less support for exchanging that capital and moving abroad. In Chapter 9, I will discuss this further in relation to broader research on gendered norms in Iranian society (particularly amongst middle class Iranian families).

Whilst the women above talked about their choice of degree as affording capital/capital growth and as a means of escaping certain cultural barriers in Iran, others spoke of moving abroad as a temporary experience and suggested they felt compelled to return to Iran and contribute to its development. Below, I present the stories of Sarah and Yalda, who, in discussing the idea of going abroad, did not appear to be trying to escape discrimination they might face in Iran, but rather co-constructed a story about their personal contribution to their discipline or about changing Iranian society for the better. Below, Sarah's story is of interest because, although she recognises the capital her engineering degree affords her (in moving abroad), she does not express this as a resource with which to challenge labour market inequalities. In fact, she views acquiring further capital (e.g. at Stanford university) as key to changing the field of computing which she believes she can do from her own room. Here, moving abroad is a mere necessity to achieving her goal of changing the discipline of computer engineering. By contrast, I illustrate how Yalda, in becoming a successful computer engineer, intends to challenge engineering male stereotypes from inside of Iran and, as such, transform the FW of professional engineering in the workplace. Here, again, engineering is positioned as having capital but this is then used to imagine a changed Iranian society rather than as a means of escape. As such, whilst Yalda considers at length the possibility of moving abroad (Stanford again is mentioned), after some reflection, she decides that moving abroad is not for her despite the capital it potentially offers. In presenting these stories, I will again highlight the important role of others (particularly family) in each account.

## 8.3 Moving Abroad as an Expression of Personal Development

### 8.3.1 Sarah

Sarah is a hardware engineering student who comes from a religious family. As noted in Chapter 5, her father is a priest/Mollah and she lives in a holy place in Iran. Sarah's mother is uneducated and is a housewife (Sarah is the only interviewee with an uneducated parent in this study). Unlike the previous students I have discussed, Sarah's story does not involve any criticism of Iran in terms of opportunities available or gender discrimination, so for her moving abroad is not a story of 'escape'.

In the quote below, Sarah speaks of her decision to choose computer engineering by drawing on a number of resources. She self-authors herself as being part of something 'great' and being able to change the world, resourced using information from a family member (brother), the importance of location (work at home), having Steve Jobs as a role model (figure), and the capital attached to computing which can be exchanged for better job opportunities. The comment regarding the location of her work, "I like to work from home and there is a limitation that I don't like to work in factory", demonstrates that her choice of computer engineering is not only motivated by the capital it offers, but also by the possibility of pursuing a successful career without having to work in locations which she sees as inappropriate, or having to adhere to a routinised daily schedule.

> *I: Do you think... despite your personal interest that has led you to choose computer engineering... were there any other key factors like a teacher or friend that influenced your decision to choose this subject?*
> *S: My brother told me that computer engineering is a good subject, it has good opportunities in the labour market. There is one more thing that I always thought about is that I like to work from home and there is a limitation that I don't like to work in a factory, I don't like to work from 8 to 5, I don't like this. There is something great in computing in that you can be in your house and even in your room and change the world. There is a famous sentence about Steve Jobs which says that he wanted to change the world with a bitten apple in his home garage and he did it. Certainly I like the personality of Steve Jobs and the greatness of this field.*

Instead of narrating a story of escape, in the quote below Sarah talks about moving abroad in terms of her own personal development: “getting to know the bigger world” and “being at a better university”. For her, moving abroad is only temporary as she states “I don't know about living but for studying hundred percent”. She also states that she does not want to criticise Iranian universities like 'others' who do so, but rather she supports their intention to develop and progress: “our university aim is to be ranked 300 in the world”.

> *I: Have you ever thought to live and study abroad?*
> *S: Hundred percent, I don't know about living but for studying hundred percent.*
> *I: Why?*
> *S: The first reason is that I want to be familiar with the bigger world out there, the second reason is the better universities that they have, I don't want to say that Iran don't have good university and I don't want to be like others who say that Iran don't have any good universities and what a place we are living in, our university aim is to be ranked 300 in the world.*

Nevertheless, despite this affiliation to Iranian universities, she also recognises that going to the USA and studying at Stanford University to become a member of their academic faculty (this is listed as a key aspiration or goal) can produce much greater capital growth (“it is good for computer programming”).

> *S: I would like to study at Stanford University and to be one of their academia members.*
> *I: Why did you choose Stanford University?*
> *S: Because it is a good university, it is good for computer programming. I have researched this, and what is more is that I found out that Steve Jobs had done some speech there. When I saw his speech there I got enthusiasm to do research on this university.*

Unlike the previous students discussed, in self-authoring her decision to move abroad, Sarah draws on a more positive relationship with her father who supports her in this respect. She believes that her father is an ambitious person who likes his children to achieve highly. Thus, her aspiration towards moving abroad is presented as part of her ambitious worldview which she believes comes from her father's influence: “he has been calling me Prime Minister since I was a child and I always

believe that I would become a big person". The position of "Prime Minister" operates as a second person identity (Sfard and Prusak, 2005) in this account, since it is assigned to Sarah by another person (her father). She then aligns with this identity, incorporating it into an imagined designated identity of becoming "a big person".

> *S: I asked my father once - does he allow me to go to the USA or not? And he told me 'why shouldn't I let you to go?', then after that I noticed that he is not just letting me to go but... more ....he likes me to go there.*
> *I: Why?*
> *S: From the way I understand my father, he has always been ambitious and he always liked to study abroad. Maybe because of the situation he had before he couldn't have achieved what he wanted to achieve. But he likes his children to be like that and to achieve the highest academic level, he wants us to progress in an academic way. Something else that was in my father was that he has been calling me 'Prime Minister' since I was a child and I always believe that I would become a big person.*

In addition, I argue that her father's encouragement affords Sarah some capital in that it resources her ability to see herself as a successful woman in the future (unlike the other participants, whose families act as a barrier to be overcome). 'Success', in Sarah's eyes, is about using her knowledge of computing to change the world, but she recognises that this requires capital which cannot yet be acquired in Iran.

To summarise, in Sarah's story it is clear that her moving abroad stems from her curiosity and her ambitious behaviour. She is not critical of Iran, whereas the others are, which may stem from her father's influence who is positioned as her ally in her story in terms of his ambition for his children. Moreover, we can argue that, in her account, the recognition of capital and capital exchange is still there as she wants to use computer engineering to create a new identity of becoming a "big person" in the future. She wants to change something in the world and she aligns herself with some famous persons such as 'Steve Jobs' in this respect.

## 8.4 Moving Abroad as an Effort to Change Iranian Society

### 8.4.1 Yalda

Yalda is a second year computer hardware engineering student and, in storying her choice of degree, she stated that, when she chose her options in high school, she had no knowledge of computing. She had chosen the mathematical science track since she liked the subject. Yalda believes that mathematics is useful as she mentioned that, when she is studying mathematics, she feels that her time is not wasted. She chose to study computing at university due to the fact that she enjoys working in an office. During the interview, she spoke of her brothers who work with computers "a lot", stating that she was curious to know about their work. However, unlike the other participants in this study, she did not speak of her family involvement in determining her choice of degree.

Like Sarah, there is no story of escaping from Iran in her account and she states that, if she goes abroad, she will definitely come back. However, unlike Sarah, there is a sense of responsibility towards her home country throughout her narrative; this also was apparent in her initial survey response which indicated a desire to change the world around her, such as changing the exam system at university and altering people's views toward women working in engineering. The title of Yalda's life movie in the survey was: 'try a different future'.

Unlike Sarah, in the quote below, Yalda does recognise or speak of gender discrimination in Iran but she believes that women can overcome such barriers and be successful in computing. In terms of successful women whom she aspires to be like, she talks about one of her classmates in her Linux class[16] (Yalda explains what Linux is in the following exchange) whom she describes as her role model. In this way, we can see the figure of a successful computer engineering woman in her account and she uses this to create and perform her identity as a computer engineer. 'Success' here is constructed as receiving many job offers and being selected by the lecturer to assist the class, which involves being positioned ahead of male students in

[16] This is an additional class outside of her undergraduate studies which involves many different kinds of people at different levels of study such as Master and Phd.

a male-dominated class. Yalda also states that this role model, plus the other working women in the class, have given her "much hope" that such success is possible for her.

> *Y: For this Linux work, for example the class I am going to, everyone are older than me, many have Masters or PhD degrees, we are about 20 people and 6 or 7 of them are women. But it is not like these 7 women came to the class for fun, they had a job and they came from good companies. Then I was thinking that it is not true that women don't have any jobs or it is difficult for them to get a job. For example there is a woman there, who wants to go to France for studying and working, but I didn't know why she wants to go there, now at the moment in Iran she has about 10 job offers from different places but she didn't want to stay here.*
> *I: You mean in Iran she has many job offers?*
> *Y: Many, she is very famous. Many want her to work in their company, and then it was in there [the Linux class] that I was thinking that women can be very successful.*
> *I: Do you think she can be your role model?*
> *Y: Definitely, when I saw this woman I got very much hope, our lecturer is a man and among all the men in the class he chose her for his assistance. Among all these men she could be the most successful one.*

Yalda's identity as a computer engineer is evident below where she describes herself in the future: "I would like to work with Linux". But in this case, rather than stating that it is her degree that offers her capital for the job market, she states that it is her knowledge of Linux (which has many uses) which enables her to achieve more capital in near future (better job opportunities). Arguably, knowledge of Linux could be seen as a derivative of studying for a degree in computer engineering (although recall that Yalda has taken an extracurricular course for this purpose). What seems important here is that Yalda does not refer to the status of the degree in the eyes of others (as a badge of cleverness), but rather justifies the status of such knowledge in terms of its use value (i.e. what Linux can do and why it might be valued). She is not merely attending the arbitrary nature of this capital here.

> *I: Where do you see yourself in 5 years' time?*
> *Y: I would really like to work and I would like to work with Linux.*
> *I: What is Linux?*

*Y: It is an agent system ....used mainly for survey and that sort of thing and I went to the class for it. My main aim is to work within this field.*
*I: Why do you like to work with Linux?*
*Y: Because it is something new which many people are not familiar with yet, and it is getting popular and it has many uses, it is gradually overtaking Windows and those who are professional in it will have better opportunities. I feel if I follow this way I will have done my best.*

In the quote below, Yalda states that her consideration of moving abroad as an option is based on other students' influence and the fashion of going abroad (thus indicating its status as a cultural model). She is curious to know why so many tend to do so: "I was thinking I should understand what applying for abroad universities means as many people are talking about it". Thus, the figure of 'other' students who opt for 'moving abroad' as an option and studying in the USA act as a figure who she positions herself against.

As such, Yalda's aspiration to move abroad is a temporary 'means to an end' and below we can see a strong sense of conflict and struggle in her account between feeling compelled to go but not wanting to invest the time, money and effort involved in moving abroad. This struggle is apparent where she dis-identifies from those students who wish to leave Iran forever ("some just study here [at university] to go and never come back") but also recognises that she may need to go abroad to become "a very successful person" ("I thought that if I go and even become a very successful person I should certainly come back"). When she talks about moving abroad, she seems to talk about going back to Iran to make it a better place to live. So, if she goes abroad and comes back she intends to use her knowledge to change something in Iran. Therefore, she is self-authoring her future identity as a different kind of successful engineer in relation to the other women she has met in her Linux class: the figure of intelligent students in her account tend to stay abroad forever, whereas Yelda states that her pathway to success does not follow this trajectory since, for her, success is about coming back to Iran and making a contribution to the development of Iran.

It is noticeable that there appears to be no mention of other friends/family who have already moved abroad with whom she can identify in this long quote. Although she has done research and knows that students from her university have moved to the USA, she does not speak of personal friends of acquaintances who have done this. If we compare Yelda's narrative here with the other students, we might notice a lack of networking capital and financial/family support in this respect. As noted in Chapter 4, social capital such as this is required to mediate access to cultural capital (in this case knowledge of how to move abroad). In Yalda's case, such social capital is absent and this may be the reason why she does not view this option as offering sufficient reward in exchange for time and financial capital she would need to invest in it. It is perhaps this deficit in social capital that motivates her comments about wanting to make a difference in Iran ("who wants to build here?") rather than elsewhere.

> *I: Have you ever thought to study and live abroad?*
> *Y: Yeah, I was thinking I should understand what applying for universities abroad means that so many people are talking about it. I have done much research on it, e.g. about the good universities around the world, or who can apply there. Among my friends there are also people who could go there, like Stanford University ... only very intelligent students could go there, like students from Hafez University.*
> *I: Many of them went to USA?*
> *Y:Yeah, mainly to the USA. I have done research about this, about how students can go there. Like first they have to take a GRE exam, then pass the TOFEL exam, then they have to complete the application form. Then if they can afford it, they pay their own fee which is very expensive. If not they have to find a lecturer who can accept them as their own TA, so they can be eligible for funding, and they can just pay their fees and their life expenditure. I was thinking that to do all of these things is very difficult for me. Then I told myself that I have to do it. But then I thought that I have to put too much effort and time in to doing these things. For example my English has to get better, but for taking the GRE exam I have to invest a considerable amount of time, and I have to spend money taking that exam, and also spend money to release my qualification. Also living abroad costs some extra money. So for doing all of these I have to put too much time and energy into it. Well if I stay here and study well I will waste much less of my time and I think this is better, e.g. some people cannot tolerate here [Iran] at all, their culture is like that, they can't tolerate it and they have to leave. But I am not like that, some just study here [Hafez University] to go and never come back, but I thought that if I go*

> *and even become a very successful person I should certainly come back. Why should I stay there? Everybody says that here [Iran] is bad and they have to go. Well who wants to build here? Why does everyone want to go? People belong somewhere, anyone who goes there [abroad] ... I am not saying they do bad things but some of them never come back which is not good.*

In terms of gender discrimination, in the quote below Yalda resists strongly the idea of gender differences, particularly in relation to studying engineering. She says that "there are some people who question why girls should study engineering, even we have a lecturer in here who thinks like that". Consequently, she tries to challenge this discrimination by giving examples of some successful women in the field of mathematics and engineering which allow her to see herself as a successful in future. The strength with which this resources her imagined future self is seen in the statement "when I see such women I become very happy", suggesting once again that these women are figures who resource her identity as an engineer. I therefore conclude that, for Yalda, storying herself as a person who can change Iranian society by becoming an expert in Linux necessarily implicates challenging gender discrimination in engineering.

> *I: Do you think in mathematics and engineering there is any difference between men and women?*
> *Y: No, if we ignore the labour market where some people prefer to recruit men, there is no difference in studying at university. For example at Hafez University there are boys and girls who study engineering, and in the national exam this year in the field of mathematics it was a woman who was ranked in first place. The top three were women and they were friends of Roya [one of her friend]. Then I became very happy, since there are some people who question why girls should study engineering, even we have a lecturer here who thinks like that, it is very bad, I haven't seen him, he wasn't our lecturer but he is in this university, I am totally against this, and when I see some things opposite this view I get very happy. For example this woman who is in our Linux class which I talked about earlier (Parvaneh) and this girl who came first in the national exam, when I see such women I become very happy.*

To summarise, Yalda self-authors her aspiration to go abroad in two ways: firstly, as a mere form of curiosity about universities 'abroad' and the status attached to them. Like Sarah, going abroad does not relate to resisting cultural barriers evident in Iran

or escaping gender discrimination. Secondly, she sees this as a means to "become a successful person" in order to come back to Iran and make changes, including challenging gender discrimination. But, ultimately, this option is rejected which may be linked to a lack of social capital and the cost she perceives in making such a move. Thus, whilst in her story there is a sense of capital growth in moving abroad to develop and make Iran a better place to live (which includes overcoming gender discrimination in engineering), moving abroad is rejected as part of this trajectory.

## 8.5 The Role of Others in Students' Decision to Move Abroad

Throughout this chapter I have highlighted how the students draw on others in making a choice to move abroad. This is consistent with the evidence I presented in the previous chapter, where I have shown that there exists a cultural practice where family members (parents, siblings but also more extended family) enter a dialogue with students in order to influence and sometimes impose the student's decision-making about their future (programme choice). I have argued that this dialogue takes a particular form which is culturally specific to Iran. In students' decision-making regarding moving abroad, the influence of family and in particular fathers seems important in how the female students describe this decision. For some students, moving abroad is a form of resistance to being told what to do by their family and they dis-identify with how they are positioned (particularly as daughters). For instance, this is apparent in Maryam's story when she tells us she made up her mind to live abroad, but her father did not support her decision and told her to come back - she resists this. Sheida is also resisting her father's positioning. She talks about her decision to go abroad when she was at secondary school but her father was not fine with her aim to leave the country at that time. As a matter of fact, he advised her to delay her decision to go away and take the national exam first which she accepted. But this appears to be a form of passive acceptance rather than alignment, as she has no other option (manifest in her financial dependence on her father). In Hiva's case, although there is no evidence of resisting her father's decision that she should study engineering, she does describe having problems with her mother. These cases then indicate a relationship between various forms of positioning by family members with wanting to escape Iran. In some cases, there is also an explicit account of escaping

wider patterns of gender discrimination which the students view as embedded in Iranian society.

In addition, in relation to the two cases who did not see ‘moving abroad’ as a means to escape Iran, the role of others were also apparent. Sarah draws on others as allies (her father) who act as a form of support enabling her to imagine herself as achieving much success in computer engineering. Having her father as an ally provides Sarah with social capital and this capital gives her the opportunity to imagine her future abroad. There is no recognition of gender discrimination here but rather a desire to change herself personally. By contrast, Yalda does not refer to ‘others’ as close family/friends but rather as figures who she has met who then resource her imagined future self as ‘successful’. Here, there is no sense of resisting or aligning with parental decision-making.

Others that already live abroad or are going abroad in the near future are also important figures in the students’ narratives since they offer imagined future self. So far, I have shown that the students’ degree programme acts as a form of capital that can enable them to move abroad, but here I argue that simply having access to this academic capital is insufficient. The students also appear to require social capital in order to allow them to imagine their future in abroad. As an example, Maryam's account here demonstrates a sequence of input from various different acquaintances and family in the USA, Germany and Canada, all of whom offer her crucial information which enables her to see herself as a successful engineer abroad. Thus, she has a network which offers social capital ‘in play’. In Hiva's story, it is clear that the figure of her sister as her ally works in a similar function, offering her information (cultural capital) required to realise this imagined future self. By contrast, Yalda does not discuss such examples of others that she knows or is aware of who have provided her with information; she states that she is curious about the popularity of ‘moving abroad’, suggesting she is unfamiliar with those who have chosen to do so. She does seem to have the sense that it is important to ‘become successful’ yet ultimately rejects this option (perhaps because she lacks the relevant social capital) in favour of staying to build Iran.

## 8.6 Conclusion

In general, we can conclude that, for these students, there is recognition that their degree programme will give them capital and that they can use this capital to imagine themselves studying or living abroad.

In relation to RQ1, my analysis of both these 'story' types (escaping and not escaping) highlights how issues of gender discrimination inherent in the structure of Iranian society (see Chapter 2) are present in the students' narratives of becoming engineers. Some perceive such discrimination as a barrier to their future progression (to overcome by moving abroad), whilst others do not appear to recognise this as an insurmountable barrier (hence willingness to return to Iran). Such perceptions also appear to be somewhat related to various forms of positioning by family members, with those wishing to escape Iran resisting parental pressures. I also argue that such pressures are a manifestation of middle class Iranian family values, whereby parents are expected to make decisions regarding degree choice, and future aspirations on behalf of their educated daughters.

In relation to RQ2 and RQ2a, I argue that the role of others in the students' narratives is crucial in enabling them to imagine a future abroad in various ways. Whilst some of the students resist how they are positioned by others (i.e. parents), many also discuss others who are going abroad or are already living abroad. I suggest these others operate as a form of social capital since they offer knowledge, insights, support in moving abroad (cultural capital) and, perhaps more importantly, allow the students to imagine themselves in similar situations.

In sum, I suggest the predominance of 'moving abroad' in the interviews is a consequence of the contradictions these aspirational women experience between their desire to become successful career women whilst facing gendered cultural models which expect women to be more family orientated. In Chapter 9, I discuss my argument regarding this further by considering how these narratives are a manifestation of the structural contradictions I outlined in Chapter 2.

# Chapter 9: Discussion

## 9.1 Introduction

The analysis I have presented in this thesis focuses on how the participants self-author their identity as mathematics or engineering students (present) and their future designated identities as successful women. In order to understand how the participants construct their mathematical and engineering identities and how this is mediated by their social and cultural circumstances, I have demonstrated the need to look at the capital they use to self-author their identities. Therefore, I have shown how the use of concepts such as cultural capital and social capital are relevant to my analysis of how individual students are choosing mathematics and engineering subjects in Iran (especially in relation to certain cultural barriers to female participation in STEM subjects).

Moreover, I have discussed how the contradictions at work in Iranian society and its cultural-historical and political structure (outlined in Chapter 2) are manifest in the participants' interviews. Arguably, a key contradiction is between: (i) dominant beliefs about patriarchal traditional gender roles in Iran, which are at times deterministic in defining who can perform specific occupations and/or take up particular life trajectories (we have seen evidence of this in the guidelines administered to Iranian universities in 2012 whereby access to many university programmes, particularly in some areas of engineering, was restricted for women); and (ii) the values and beliefs of aspirational middle class women who are keen to progress or become ‘successful’ in the labour market (including women). In Chapter 2, I discussed the socio-historical development of the aspirational middle class after the Cultural Revolution in 1979 and here I suggest such aspirations as a form of capital are a product of this cultural-historical context. It is this contradiction which I argue shapes how the women exert their agency when narrating their decisions and future aspirations during the interviews. For example, gendered expectations regarding future employment or degree subjects are defined as a cultural barrier by some of the women in this study, and in some cases this barrier is narrated as

resourcing a sense of agency whereby they attempt to overcome such limitations by escaping Iran. This chapter aims to explore the manifestation of such contradictions further by addressing the study's two RQs:

1. How are the cultural-historical-economic structures and conditions of Iran manifest in Iranian female STEM students' narratives regarding their choices, experiences and aspirations?

To address this, I discuss the forms of capital apparent in the students' narratives about their choices, experiences and aspirations which, I argue, are a means to 'see' such structures and conditions in their (and my own) data. This, therefore, addresses RQ1a which asks: what forms of capital are apparent in female students' narratives about their choices, experiences and aspirations?

2. How do Iranian female STEM students position themselves amidst such cultural-historical-economic structures and conditions in Iran?

Here, I explore RQ2a which asks how the students have displayed a sense of agency in their narratives about their choices, experiences and aspirations.

## 9.2 RQ1a: What Forms of Capital are Apparent in Female Students' Narratives about their Choices, Experiences and Aspirations?

My analysis of students' narratives has generated some themes which directly relate to the concepts of capital in narrating their mathematics and engineering identities. I have summarised these themes below.

### 9.2.1 An Engineering Degree as a Form of Capital

In Chapter 7, I have shown how the participants narrate an engineering degree as offering capital which can then be exchanged in the labour market for employment upon graduation. Moreover, engineering is seen as offering more capital when

compared with mathematics and this appears to be a key factor which is implicated in the students' decision-making about choice of degree subject. This appeared in the women's narratives in one of two ways: (i) they chose to study engineering and therefore align with the capital it offers; or (ii) they chose to reject the arbitrary nature of this capital and opt for mathematics instead.

In relation to (i), we saw in Chapter 7 how the students tell of choosing to study engineering to enhance their social status and this also appeared in some students' survey responses. These students discussed exchanging their good grades in the Konkur for a higher status degree and higher status career - like a badge (capital) to present them as clever. We also saw how some mathematics students in the survey stated that they had chosen mathematics due to not attaining sufficient grades in the national entrance exam to access engineering degree programmes, which they recognised might be seen by others negatively ($2^{nd}$ person identity), a perception that was evident in Mona's story when she discussed her lecturer who had informed the group of their status as 'engineering failures'. Thus, I argue there is evidence of a socially shared perception (cultural model) that access to the capital that an engineering degree offers is restricted to an elite few who possess the requisite entry qualifications.

In relation to (ii) (above), in Chapters 6 and 7 I highlighted how Zahra and Mona rejected the capital engineering offers (despite being able to access it) because of its arbitrariness (i.e. its status as an instrument of exclusivity), and instead chose mathematics only because of its nature (use value). However, in Mona and Zahra's story we notice that a mathematics degree is presented as having some capital which they intend to exchange to be a successful mathematician or a mathematics teacher in the future. But this value is defined in global terms in relation to a global field of STEM employment opportunities rather than locally in Iran: Mona intends to become a mathematics teacher in the USA and Zahra aspires towards what is arguably a Eurocentric version of mathematics (I discuss the distinction between global and local later). In sum, when I say mathematics is seen as secondary to engineering by some, this does not mean mathematics has no social status or capital but rather less than engineering.

In addition, I have argued that Zahra and Mona's choice to study mathematics involves some resistance to the exchange value such capital offers and its arbitrariness. This was most clearly articulated by Zahra, who, despite pressures from her family to opt for engineering as a higher status subject, persisted with mathematics because of her love for its 'beauty'. In contrast, Mona's story is more conflicted: she suggests her preference for studying mathematics was influenced by her love of mathematics and her ability to do mathematics (having studied at a more academic school), but she also reported that she had become aware that engineering offered more status whilst at university, and thus manifested a shifting and conflicted mathematical identity.

### 9.2.2 The Role of Family in Choosing to Study Engineering

Further evidence regarding the role of capital in these women's decision-making is presented in Chapters 6, 7 and 8, where I showed the role of family as an influence. This concurs with the findings of several scholars who believe that family encouragement plays a significant role in encouraging women in HE (Khavar et al., 2006; Shavarani, 2006; Rezaei, 2012), since it is widely accepted that Iran is a society (as in many other places) where "education is a major determinant of class mobility" (Farrokhi-Khajeh-Pasha, 2012, p.2). However, whilst family influence is emphasised in a vast body of research the world over (Hashimi et al., 2006; Johnson, 2011; Henderson et al., 2000), in my research I have noted how this influence takes a particular form which may be specific to the value of engineering in Iran. Firstly, when the participants noted that their families encouraged them to study engineering, they referred to the family practice of owning their daughter's decision-making in terms of choice of degree programme. Students' accounts, here, demonstrate a sequence of input from various different family members, each having the right to voice their opinion. Secondly, in Chapter 7, I have shown the high status of the degree as a form of capital and, therefore, it is also possible that such capital offers status to the family. In this way, the family practice of 'having a say' in the women's decision-making mediates and is mediated by their access to engineering as a form of cultural capital (in cases where they chose to align with family influence and opt for engineering to obtain a high status degree as in the case of Maryam, Hiva and Sarah). As an example, Hiva's choice of EE is shaped by her father's positioning of

her ("he told me you can be an engineer"), so her father acts as an important figure in the story who directly influences her 'choice' to study electronic engineering. Therefore, I argue that this family practice acts as a form of social capital exchange as it provides access to what has value in the field, even where this capital is not normatively available to women (see below).

This is supported by Bourdieu (1986) who argues that capital growth can take place through family practices, and early experience in the family may well be a key factor for development of a habitus which enables one to exchange the capital they have acquired, particularly in the field of education (Bourdieu and Passeron, 1990). As such, these women's class position in society is crucial to their access and exchange of capital (choosing or not choosing engineering), and this family decision-making practice may be a key site where such capital is exchanged. However, I am not suggesting that such family decision-making brings about a deterministic relationship between class position and 'choice' of degree; it is part of a more complex process whereby access to cultural capital via a social network (e.g. family influence) must be engaged with and taken up 'in practice' by the student (e.g. doing engineering).

As noted in the analysis chapters, I have also presented cases of resistance to family influence and the arbitrary value assigned to Engineering as a degree. As Holland et al. (1998) note, in practice, we have space for alternative possibilities to occur. This is evident in the case of Zahra, where she resists the family practice and its inclination for capital growth to pursue her passion for consuming mathematics. So, the family practice of 'having a say' in choosing the programme is visible in Zahra's narrative but is not presented as directing her decision.

To explore the status of engineering and mathematics as a form of capital and its role in framing the women's decisions regarding which university degree to enrol on, I now consider the mechanisms which provide these subjects with exchange value or status. Firstly, I discuss the role of the Konkur in ranking the value of different degree programmes (i.e setting their exchange value), but I also look at how the gendered cultural-historical-political structures and conditions in Iran (evident in the

women's narratives) have both made such access possible whilst also proving problematic.

### 9.2.3 The Role of Konkur and its Impact on the Students' 'Choice' of Degree

In Chapter 2, I discussed the structure of the Konkur (national university entrance exam), the validation given to its grade outcomes, and how such grades provide access to a ranking of university programmes (i.e. higher grades apply for engineering, lower grades apply for mathematics). This explains the claim made by several students in their narratives that engineering is viewed as prestigious, since it can only be accessed by the elite few who attain high marks in the entrance exam. In this sense, the students narrate how their entrance to an engineering degree entails an exchange of one form of academic capital (prior attainment) for another form (an engineering degree). Nevertheless, as Bourdieu (1990) notes, such forms of capital are largely arbitrary in that what distinguishes one student's grades in the entrance exam from another is really very little (much likes the arbitrary Grade C at GCSE mathematics in English schools).

In terms of hierarchical relations between engineering subjects, electronic engineering demands the highest grades, computer software engineering requires slightly lower grades, and computer hardware engineering demands the least amongst the engineering subjects (this was claimed by the Educational Deputy at the Faculty of Computer and EE where this research took place). In fact, EE is ranked the highest and most difficult to access in terms of National Entrance exam rankings and, in this study, women are under-represented in both electronic and hardware engineering at Jesus University. As such, the women in this study (especially in electrical engineering) narrated their choice of engineering as being part of an elite minority group, and in Chapter 7 I noted their sense of entitlement (habitus of entitlement) to being successful (i.e. they are aware that they are part of an elite few, having accessed engineering through their performance on the Konkur). This argument links to the literature in Chapter 3 on the elite status of mathematics (e.g. Rodd et al., 2006. However, here my argument is about engineering and not mathematics, which I suggest is a marked difference between the Iranian context and the westernised contexts focused on in previous literature. For instance, Rodd et al.

(2006, p. 25) discuss female students in the mathematics community whose self-perception is one of being both ‘invisible’ and yet ‘special’. However, in this study, some of the women discuss a cultural model that mathematics is seen as a failure subject, which challenges the notion that mathematics is a marker of intelligence or ability (as mentioned in Chapter 3). Here, mathematics does not carry the same kind of capital as engineering in that it leads to careers such as teaching which have a lower status in Iran. The next section goes on to discuss the gendered nature of such eliteness (being a woman engineer) in more depth.

### 9.2.4 High Aspirations

In Chapter 8, I have shown evidence of high aspirations, particularly amongst the computer engineering students. For instance, in Yalda's narrative, we see her aspiration to further her own personal development in an effort to change Iranian society. As with their recognition of the capital that engineering carries, such high aspirations also mirror gendered expectations regarding female education, careers and success in middle class Iranian society (outlined in Chapter 2). In this respect, the participants in this study position themselves as ‘highly aspirational’ with many of them aspiring to global success (e.g. CEO of Google, attending Stanford University, winning the Fields Medal). Clearly, such aspirations had an impact on their mathematical and engineering identities in terms of their reasons to engage their subject in the present and their decision-making about their future selves. As an example, in Maryam’s story, her aspiration towards going abroad seems to impact on how she reports her engagement in the present and decision-making, as she prefers to study EE rather than architecture in order to move abroad.

As shown in Chapter 7, these participants spoke about their aspirations in such a way that they can be said to enact or reflect a habitus which is rooted in their position in the field as middle class women. Thus, they narrated a sense of entitlement to be successful because of the capital they hold (such as family or teacher support) and/or are in the process of acquiring (e.g. an engineering degree). There was very little consideration amongst the women of a different future involving starting a family or opting for a lower status vocation such as teaching (Mona reports that she wants to be a teacher but in the USA, as she believes it is a higher status career there). The

majority aspired to be successful career women and, where they perceived barriers to this trajectory, they exerted agency to circumnavigate such barriers (e.g. moving abroad).

This research finding is in contrast with the findings of previous scholars in Iran who have shown the dominance of more traditional aspirations, such as becoming an educated mother and wife (Khavar et al., 2006; Hashimi et al., 2012) in Iranian female graduates. In Khavar et al.'s (2006) research, women are reported as going to university to fulfil their personal expectations rather than to seek a job in the labour market. As such, female university graduates are reported as satisfied with morality and internal goals rather than seeking external goals such as having a career. Personal expectations refer to women who attend university to gain social prestige in order to acquire a better husband and become an educated mother (Khavar et al., 2006). Therefore, women are seen as going to university to maintain traditional values.

Some other studies have highlighted a sense of conflict experienced by women in Iran between aspiring to traditional roles for women (being an educated mother and wife) but also aspiring to work in the labour market (Shavarani, 2006; Rezaei, 2012). Such a conflicted set of aspirations is largely absent in my data, as the majority of the participants see marriage as a barrier to their success rather than something they aspire to (explained more below).

However, it should be noted that, in this study, I have focused on mathematics and engineering students (which are high status subjects), whilst the studies referred to above involve female graduates of a range of degree programmes. In this respect, I contend that the capital conferred by engineering may be associated with how these women position themselves differently from those in the studies mentioned above.

## 9.3 RQ2a- In What Ways do Female STEM Students Display a Sense of Agency in their Narratives about their Choices, Experiences and Aspirations?

The way my participants discuss the constraints that they face in Iran in terms of accessing a labour market dominated by men has allowed me to explore how their choice of degree is narrated as a means of expressing agency. That such constraints or barriers are experienced by women in Iran is widely recognised by scholars such as Rezai-Rashti (2011), Moghadam (2003), Rezaie (2012), Shavarani (2006), Moghadam (2009) and Povey (2010). These authors discuss the reasons for the lack of women in the labour market, focusing on barriers such as discriminatory recruiting practices which prevent women from accessing male dominated jobs. This discrimination was discussed by some of the women in this study (even when positioning against the idea that it exists (like Yalda, who meets successful computer engineers in her Linux class) and is also apparent in the research literature. For instance, Rezai-Rashti (2011) interviewed female Iranian workers regarding the barriers they faced in the labour market. Here, the participants spoke of discrimination such as not wearing 'proper' clothes according to Islamic values, which is a kind of discriminatory practice for women (see Section 2.7 for more detail). Similarly, my findings have some commonality with the work of Shavarani (2006), who discussed the case of a 21 year old female Iranian university student (called Goli) and the perceived gender discrimination she negotiates in pursuing her educational aspirations:

> *I want to work. I don't want to think that I will have to return to Kermanshah (her home town) and stay all day at home. I mean, it's important for women to be mothers. That's the most important role in society. But I want to participate in society and not be at home all day. I want to apply what I have learned in college. My mom worked outside the home, but she was just a teacher. Women who want to work outside the home generally end up as teachers. I don't want that. I want to do more. I have to do more. But in Kermanshah (her home town) women simply don't work, that's just the way it is (Shavarini, 2006, p.51).*

As we can see above, Goli lives in contradiction. On the one hand, she is aspirational as she wants to be independent by having a better job (compared with being a

teacher). On the other hand, gender discrimination is a barrier to her success as 'women simply don't work' in her home town. The use of 'But' is a key indicator of this contradiction. Related to this argument, Shavarani (2006) highlights how educated and powerful women can be a threat for a traditional government and patriarchal society, stating that:

> *The growing number of college-educated women presents a social dilemma for Iranian government (IRI) where men are perhaps threatened by educated women's sense of self and independence. This poses a threat to their maleness, to traditional power structures: to patriarchy. (Shavarini, 2006, p.52)*

Shavarini's ( 2006) argument is visible in my data, as the women both describe and reject forms of discrimination and see the male dominated labour market as a barrier to circumnavigate (even if this means moving abroad). Ultimately, the gender discrimination that the women talk about in the interviews is conflicted with their aspirational behaviours which, as I have argued in Chapter 8, creates a need for improvisation (moving abroad) in the way Holland et al. (1998) suggest. Below, I discuss further the contradictory discourses which enabled or pushed the need for improvisation in these women's accounts of their imagined futures.

### 9.3.1 Contradictory Discourses Apparent in Female Students' Narratives

In order to understand how contradictions in the structure of Iranian society are apparent in the students' narratives, we need to understand the increasing numbers of women entering STEM subjects at university (outlined in Chapter 2), as it relates to shifting cultural and political attitudes after the Islamic revolution in 1979. As shown in Chapter 2, the 2012 HE guideline, which aimed to reduce the numbers of women enrolling on certain degree programmes, is part of dynamic ongoing process of policy change driven by shifting ideologies about gender. As mentioned in Chapter 2, the key time periods in Iranian policy research are typically described as: 1) 1980-1987: traditional period; 2) 1987-1997: transitional periods; 3) 1997-2009: modernisation periods; and 4) 2009-2015: the resurgence of traditionalism. As noted in Chapter 2, prior to 2009, it is generally accepted that women in Iran were actually encouraged by educational policy to study STEM subjects which engendered a

discourse of 'success' for women as a means to providing the human capital to re-build or produce economic development in Iran after the Iran-Iraq war.

Given the women in this study have grown up in this era and their parents grew up pre-cultural revolution, it seems that ideas around female aspirations and the need for human capital are embedded more deeply in culture/history in Iran. Therefore, I argue that the predominance of 'successful career woman' as an imagined identity in these women's narratives suggests this cultural-historical context is manifest in their family habitus, hence they express a sense of entitlement to study what might be seen as an elite, high status degree (i.e. 'I achieved high grades so I am able to take up (or discount) engineering as a high status subject'). Some of the women seem to identify with the exchange value engineering offers and/or others they feel able to resist it, but crucially none of the participants questioned whether they 'belonged' or had a right to access university engineering or mathematics as a woman. This contradicts research in western contexts where successful women in STEM subjects report themselves as fragile, 'not belonging' (Solomon, 2012) or 'invisible' (Rodd and Bartholomew, 2006). The women in this study did not seem to question their sense of belonging on their degree programme, even when female students were a minority (as in EE).

Nevertheless, despite this sense of belonging and a sense of entitlement, the evidence presented in Chapter 8 shows that these women are also negotiating and immersed in the resurgence of traditionalism (limiting women to normative gendered roles of motherhood and domesticity). This is indicative of the contradiction highlighted in Chapter 2, where women are expected to be aspirational (by their families, popular culture, policy maker, etc) but face discrimination when they attempt to pursue such aspirations. It is this contradiction which I argue explains the sense of improvisation narrated by some of the students in this study, as outlined in Chapter 8 (moving abroad). For example, the conflict between their desire to acquire qualifications which hold capital in Iran but also to leave the country (improvisation) and its perceived barriers to success (see below for more detail). Here, I argue that their desire to leave the country and transcend the barriers they perceive to be problematic involves recognising the local-global relationship at work in this context. Whilst becoming a 'successful woman' and exchanging an engineering degree for further

capital in the job market is limited in the local Iranian context , the women are also engaged with a global 'field' of engineering where such capital can be exchanged more readily. Thus, we can see that there is a complex relationship at play between local and global fields, which accounts for variation in what has value or is acceptable in cultural, historical and even economic terms. In this case, it seems the relationship between local and global engineering fields comes to the fore because of the contradictions the women experience in wanting to have successful careers in a cultural system which actively attempts to limit female participation in the workforce (as is evident in the 2012 HE guidelines).

### 9.3.2 Improvisation with Capital

Throughout the analysis chapters, I have shown how the engineering students use the specific capital their degree offers to narrate their future designated identities as successful women in different ways. Some discuss the option of going abroad as a means of escape from perceived gender discrimination, whilst others report their intention to use the capital their degree offers to make Iran a better place to live. I have argued in Chapter 8 and above that the former demonstrates Holland et al.'s (1998) notion of improvisation because there is some evidence of reflection or calculation of how to get round the structural gendered barriers they perceive in Iranian society (i.e. by moving abroad). Therefore, they use the capital their degree provides (and other forms of capital too – social and networking capital) to give them more space to do this.

As an example, Maryam implicates her gender in accessing such opportunities; she appears to see this also as offering capital in terms of gaining employment abroad ("women can easily work in it and other countries also valued it"), and she even recognises that she is unique and special because her gender gives her some capital in western contexts, where the need to promote women in mathematics and engineering is discussed more (suggesting her knowledge of the global engineering field). In sum, some of the women in this study appeared to use the capital that engineering offers to improvise a sense of escape: they are middle class women who are moving into more liberal parts of the world in order to resolve the structural contradictions they experience in Iran. These women position themselves as highly

aspirational but subject to gender discrimination in the labour market and through the ideology of government policy. Consequently, improvisation, in this sense, is about exerting agency, which can motivate new action to create alternative possibilities to get round problems. The students apply agency in one sense (over gender relations) but only because they have capital which puts them in a position to do so. As such, we can argue that the presence of improvisation in these women's accounts is a consequence of the structural contradictions regarding gender and class in Iran, which I have emphasised throughout this thesis and which are particular to this local context. Once again, there is evidence of some conscious awareness of global cultural, historical values, as well as those which are local to Iran, which are drawn upon in the construction of their identities as engineers/mathematicians.

## 9.4 Validity and Trustworthiness

In this section, I discuss the strength of the findings as a claim to knowledge, before moving on to discuss how such findings make a contribution to the research literature. Here, I emphasise that it is the interplay between theory and empirical evidence which has allowed me to demonstrate rigour in the argument put forward so far. For instance, to understand how the cultural-historical-economic structures of Iranian society are manifest in the participants' narratives about their choice of mathematics and engineering programmes at university, I have used Bourdieu's concept of capital which has highlighted what is valued and what has exchange value in this particular context. As noted in Chapter 4, what holds capital in a given context is defined structurally but is also played out locally, hence this concept has allowed me to claim evidence of structures in the students' narratives. Similarly, I have also used the concept of cultural models to explore how specific themes evidenced across the students' narratives are manifestations of ideologies in operation in Iranian society.

Therefore, the theoretical framework I have used has focused on bridging what can be interpreted as locally situated meanings (i.e. specific to the students' narratives) and wider socially shared beliefs/stories. For instance, in Zahra's narrative (Chapter 6) I show how her choice of mathematics and her experience at university have

blended together to allow her the opportunity to imagine herself as a successful woman in future. Drawing attention to this story as an example of a 'success against odds' narrative which is recognised in the literature (e.g. see Black et al., 2010), has allowed me to understand how the socio-economic structure of Iran is presented as restricting her 'odds' of being a mathematician which are then transformed into new action to resource her agency. I argue that the validity of the analysis I have offered here lies not only in the quality of the data presented (which were rich and substantive in most cases) but also in the degree to which key themes (such as resistance and moving abroad) was shared across the narratives.

Another key facet of my claim to validity, here, relates to my own position in the research as someone who has knowledge of Iranian society, culture, etc., and has also experienced studying mathematics as a female student at an Iranian university. This has allowed me to interpret and give sense to the data by utilising my inside knowledge. In this respect, I believe that knowing my participants' experience at university was useful: it enabled me to understand how they position themselves in terms of gender, curriculum activity, etc. However, my position as a theoretically informed research has also allowed me to identify 'taken for granted' meanings, which might not typically be questioned or noted by an insider. As such, I argue that my own positionality in this research, and my sensitivity to the local context in which my participants are located, has enabled me to analyse the students' narratives as a means to answer the RQs appropriately. Without such inside knowledge, it would have been difficult to recognise evidence of structural conditions and the possibility for agency manifest in the students' narratives.

## 9.5 Contribution to knowledge

This research has generated a contribution to knowledge in several distinct areas and, as such, offers potential value for further studies interested in how gender mediates access and participation in STEM subjects at university, particularly in relation to engineering and mathematics. I argue that this contribution has been shaped by the particular cultural-historical context of the study ('1979-2015 Iran') and its contradictions which have implications for gender through what we might term 'a

female brain drain' from Iran. Below, I outline the key areas of literature that this thesis adds to, with an explanation of how it makes this contribution.

### 9.5.1 Identities of 'Not Belonging': Mathematics/Engineering as a Female Student

Existing literature on gender in relation to mathematics and engineering (Solomon, 2012; Solomon, 2011; Black et al., 2012; Mendick, 2005a; Mendick, 2005b) has emphasised the notion that both mathematics and engineering are viewed as masculine subjects (Blinckenstaff, 2005; Rokis, 2011; Kuzmak, 2010; Sonnert, 1995a). For instance, Solomon (2012) highlighted how many women perceive themselves as 'not belonging' in the world of mathematics, even when they are successful in it, due to cultural representations that engineering/mathematics is inherently male. Thus, there is a dominant theme of fragility in the research literature on female mathematical and STEM identities, which I argue this research directly challenges (Solomon, Lawson and Croft, 2011). In the case of EE especially, the elite status of the subject (accessed mainly by male students) is seen as offering capital, even for female students. But, crucially, this capital holds value not only in the local field, but in the global engineering job market where their status as female engineers offers double reward (i.e. being female and being an engineer). Hence, rather than describe a sense of 'not belonging', the women speak with a sense of entitlement which I have argued is derived from a cultural family habitus orientated towards success and the accumulation of previous capital in education, having scored highly in the Konkur (mentioned in Section 9.2.3). Furthermore, in the case of Zahra in Chapter 6, we have a female mathematician who describes her intrinsic love of mathematics which dominates her aspirations to become a mathematician to the extent that this is robust enough to resist family expectations and pressure. Thus, she provides us with a confident mathematical identity which does not appear to resemble the fragility identified in Solomon et al. (2011) and elsewhere, even when she recognises that doing so means aligning with a masculine discipline.

Here, I argue that the study's location in a non-western context (Iran), which encompasses different socio-cultural and historical structures and ideologies, is

significant to this contribution to knowledge. By exploring the presence of such structures and ideologies in the narratives of my participants, I have been able to unpack how Iranian culture is present in the gendered construction of identities in this context.

### 9.5.2 Analysing Global and Local Structures in Female Student's Narratives

In addition, I argue that this is the first study to recognise global-local dynamics in studying the construction of female STEM subjects' identities, which arguably is an important addition to theoretical accounts of identity-in-practice. Choudry and Williams (2016) note in their review of Holland et al.'s (1998) theory, how these authors focus heavily on the production of identity in localised 'figured worlds' (e.g. the college data scene). They critique their approach for failing to recognise what Bourdieu refers to as 'the field of power' which structures relations between local fields/figured worlds. My study addresses this critique in that it not only recognises how social structural contradictions in Iranian society are manifest in the women's narratives (RQ1), but it also recognises how Iran's position in the global context is significant to these women's stories. For instance, the women's perceptions of localised barriers to future career success and the valued capital of their engineering/mathematics degrees are seen as different from what takes place in other countries where female engineers/mathematicians are more highly valued. For some this means escaping Iran, but for others it means using such opportunities to return back to Iran and make a difference. Therefore, the Iranian context has been particularly important in helping me to develop the theory here and address Choudry and Williams' (2016) critique.

As noted in Chapter 2, the context of the STEM sector in Iran takes a particular cultural, historical and social form which is rooted in Iran's recent history, the shifting ideological positions of the state/government and the economic demands placed on the country. This context, therefore, appears to produce different kinds of STEM identities for the women in this study, which are mediated by their position in relation to engineering as a form of capital. In the Iranian context, engineering is valued as the elite subject for women to study, with relatively high enrolment, particularly in computer engineering. This challenges the lower status of the subject

in the UK, for example, with very small numbers of women wanting to study this subject. Similarly, the way the women describe mathematics as a 'failure subject' contrasts with many western contexts where studying mathematics is seen as the elite activity of the white, male, privileged few (Walkerdine, 1998; Mendick, 2005a, 2005b). In this study, the women seem to recognise this distinction (although without conscious reference to male privilege) and use it to narrate their own imagined futures.

Therefore, in my research I have shown that, whilst identities are mediated locally in part (as members of their degree programme or family), these participants also see themselves living in a global world which impacts how they view the capital their degree offers. As such, my analysis of the Iranian context makes some new demands for Holland et al.'s theory which, as Choudry and Williams (2016) suggest, emphasises the local at the expense of broader social structures. So, the contribution to knowledge here is an adaptation to the theoretical framework offered by Holland et al. (1998) in order to understand the global as well as the local relations as they are manifest in the women's narratives. The cultural model of 'going abroad' draws on the women's account of others they know, such as family members, who have already gone abroad and send messages back, which become part of their figured world (particularly in the family). Plus, they identify with international symbols of success, such as the late Steve Jobs or Maryam Mirzakhani. Thus, they situate their capital in this global context, which helps them to navigate the gender relations in the local context of Iran.

### 9.5.3 Analysing the Brain Drain from Iran

Finally, the findings of this study make a contribution to context specific literature regarding the apparent 'brain drain' from Iran. As mentioned above, there exists a contradiction between historical/political need for successful women and the more recent push to restrict the roles women can take up in Iranian society. These highly aspirational young women are negotiating contradictions in policy and in Iranian society which expect women to make a contribution to the economy but restrict women's roles too. This manifests itself in their narratives through: a) their alignment or resistance to the arbitrary exchange value their degree offers or b)

because it means they can move abroad (this is a form of improvisation to become successful), others resist exchange value instead insisting on the use value of studying at university (like Zahra) or an alignment between the two. The existing literature on the 'brain drain' from Iran like that of Torbat (2002), Entezarkheir (2005) and Chaichian (2011) mainly emphasises problems in government policy and practice such as the structure of university admissions[17] and the dominance of Islamic studies in the university curriculum. All students are required to study Islam whilst at university, which might include studying the Quran and/or studying Arabic as part of their degree. This is mentioned by Torbat (2002), who suggests this may be associated with alienation on the part of students and the predominance of 'moving abroad'. As yet, there is very little research which has focused on subjective motives to leave Iran and the complex relationships which enable some to do this (e.g. family relations which act as a 'pull and push' mechanism at the micro level). This research attempts to unpack the complexity of family relationships which inter-connects with engineering as capital to produce a motive to move abroad. I have shown examples of students who wish to escape Iran to resist parental pressures but I have also shown examples of students who have the support of their families, instead moving abroad to gain skills and then return to Iran to make a contribution to the development of society.

## 9.6 Conclusion

I conducted this study in order to understand female students' perceptions of studying mathematics and engineering at university in Iran. Therefore, by using a narrative approach, I have explored the manifestation of socio-historic-economic structures in my participants' perceptions of their experiences on STEM programmes and how they narrate their choice to study such programmes and their future aspirations. The findings suggest six main themes: 1) engineering acts as a form of capital which can be exchanged for further capital or status; 2) families are a significant influence in choosing (or not choosing) to study engineering/mathematics, since they infer social capital on students; 3) the Konkur

[17] For instance, in public universities, the family of veterans and martyrs received special quotas which allow them to increase their Konkur grades and thereby choose a higher ranking subject. This is viewed as widening participation in universities, thus increasing numbers of highly qualified graduates who then leave Iran.

(university entrance exam) appears to act as a key (element) leaver in affording status to engineering subjects as a form of capital; 4) the capital that engineering degree programmes then afford aligns with a sense of entitlement (habitus) which is evident in my participants' high aspirations; 5) this produces local contradictions between 'career success' and barriers associated with being female (e.g. gendered discrimination) which must be negotiated; and 6) one way to resolve such contradictions is to improvise with the capital engineering offers and move abroad or change Iranian society.

In this chapter, I have outlined the contribution to knowledge that this argument makes by a) challenging the notion of fragile STEM identities and b) suggesting the need to recognise how local-global relations may produce contradictions which then resource agency in the students' accounts, providing a motive to resist or seek to change the local context. My focus here is how my participants come to see themselves in a global context and how they understand their identity as situated in a context where mobility from country to country is feasible. For these women, it appears that this situation resource their resistance to what they mostly perceive as local constraints specific to Iran and, as such, their sense of becoming a successful woman buys into belonging in a globalised world.

# Chapter 10: Conclusion and Implications

## 10.1 Introduction

The purpose of this chapter is to outline the implications for policy and practice which arise from this study's findings and to discuss potential limitations of the research and opportunities for future research. In this respect, first, I will summarise the findings and the contribution to knowledge before reporting on the implications for female participation in STEM subjects globally, particularly in relation to increasing the empowerment of women in relation to engineering and mathematically demanding careers. My study recognises an engineering degree as a form of capital which can facilitate empowerment for women but also other social groups. However, the findings recognise that capital alone is insufficient to encourage participation in STEM subjects and instead I argue that the promotion of agency, identity and improvisation are additional factors which need to be considered. Second, I will consider the implications of these findings for Iran and will consider how the findings are useful for those focused on changing women's position in relation to STEM subjects by changing policy. Finally, I will also outline the limitations of the study and how the future research might address these. In summary this chapter aims to explore the implication of the findings and the contribution to knowledge which briefly summarised below.

## 10.2 Summary of the Findings

In answering RQ1 I have investigated the cultural-historical-economic factors at work in the local context in Iran and have identified the forms of capital that mediate my participant's 'activity' and decision making in choosing mathematics or engineering programmes in Iran. Here, the key findings are that an engineering degree appears to act as a form of capital in Iran which is readily drawn on by some students (even when they are not particularly interested in the subject) but is actively

resisted by others. I have also found that family influence on choice of degree programme is significant in this context, as is the Konkur exam which filters who can access the capital engineering offers. Finally, I have also identified how those who select engineering programmes (both electrical and computer engineering) appear to be highly aspirational, with some intending to use the capital their degree offers in order to move abroad and gain what they perceive to be better opportunities than can be accessed by women in Iran.

RQ2 addresses the positionality of the women in relation to cultural-historical-economic factors and here I have described how they display a sense of agency which involves improvisation using their capital (moving abroad, for instance) but also some evidence of world making (changing Iran). I have highlighted how such positionality emerges out of contradictory discourses at work in Iran where women are accessing engineering (and mathematics) in large numbers but are not able to translate their degree qualifications in to secure employment in the labour market. It is this contradiction which gives space for agency and consequently, the women in my study reflect on how they can navigate or transform the context in which they are situated.

## 10.3 Summary of the Contribution to Knowledge

The first contribution to knowledge outlined in Chapter 9 addresses the notion of 'not belonging' in relation to female students studying mathematics and engineering which is prevalent in research literatures in the UK/USA. My findings show that there is a 'sense of entitlement' in the women's account as they describe their future aspirations to be some one big in the future (e.g. manager at Google, teach at Stanford). Such aspirations are described in relation to 'moving aborad' and the improvisation this entails.

The second contribution to knowledge addresses the notion of 'localism' in Holland et al's (1998) theory which is about the production of identity in localised 'figured worlds'. The empirical findings of this research indicate that there is a 'sense of globalisation' in the women's narratives which relates to the production of identity

in a globalised ‘figured world’. Here, they recognise gender as capital in the engineering labour market outside of Iran (e.g. in Canada/Germany) where recruitment of suitably qualified female engineers is typically low. This contribution to knowledge addresses the critique of ‘localism’ made by Choudry and Williams (2016) in relation to Holland et al’s account.

The third contribution to knowledge relates to the apparent ‘brain drain’ from Iran. Here, Iranian research literatures focus mainly on government policy and practice at the macro level as a ‘cause’ of the brain drain. However, this research attempts to unpack the notion of ‘escaping’ which inter-connects with family relationship at the micro level. Escaping in this sense relates to resisting parental pressures and gender discrimination and therefore, I look at this issue through the perceptions and narratives of female students themselves.

## 10.4 Implications for Improving STEM Participation Globally

This study presents findings which are of use to those organisations interested in increasing female participation in male dominated subjects such as engineering (in the UK this might refer to organisations such as WISE, UK engineering, and Science Grrl). As mentioned in chapter 3, existing research argues that the difficulties that many women encounter in choosing and studying male dominated subjects are mainly related to their social identities which are mediated by gender, class and culture (Solomon et al., 2014). My study brings all these factors together through adopting an intersectional approach which recognises women’s class position and how this is realised at the local level. Furthermore, it adds to this the historical and political context in which women are situated and considers how this context mediates their participation, decision-making and aspirations to study mathematics and engineering. For instance, in chapter 2, I have shown how policy changes across different historical eras in Iran have changed and the interplay with cultural norms has produced specific understandings of what it means to be ‘a middle class young woman’ in this context. This localised context therefore, is important in shaping the findings of this study. In one sense, the approach of projects such as Enterprising

Science (Archer, 2013-2018) aim to address intersectional inequalities relating to gender and class by promoting the distribution of science capital so that more students have access to it (Archer et al., 2014). Whilst this seems worthwhile in terms of fostering interest and awareness of what it means to study science, engineering (and to a lesser extent) mathematics, it has limitations in that a wider distribution of capital, inevitably leads to its devaluation since according to Bourdieu, its function is to serve the unequal distribution of power operating in the field of power (Black and Hernandez-Martinez, 2016). To address this, what is required is a critically reflexive approach which recognises the operation of capital exchange and seeks to emphasise the 'use value' of knowledge rather than its exchange value. By doing so, it may be possible to enable women to use the knowledge they acquire (through secondary school and university) to realise more socio-political changes in the way capital is distributed and how it might be exchanged. Clearly this is a difficult project in a context like Iran, but would involve working with organisations such as WSCC, Bureau of Women's Affairs (Ministry of Education) and Center for Women's Participation (Office of the President).

## 10.5 Implications for Policy and Practice in Iran

As can be seen from this research, the Iranian context contains several contradictions and conflicts and therefore, this study provides a potentially interesting opportunity to look at policy and practice on STEM participation. For policy makers in Iran, this research captures the voices and experiences of Iranian women who want to study engineering and mathematics in Iran. Whilst the benefits of hearing such 'voices' might not be immediately obvious, it does offer insight into the apparent 'brain drain' which as noted in Chapter 9 is a concern for policymakers. As can be seen in the case of engineering students, it seems that gender discrimination both at university (from lecturers) but also in the job market requires these women to express their agency and improvise to overcome such barriers by moving abroad. In relation to engineering specifically - on the one hand, an engineering degree can offer capital and enhance aspirations but on the other hand there are restrictions on their participation in the labour market, and so some students report using the agency and resisting the local norms to go elsewhere. For some of

these women, their degree might have been any subject so long as it offered them and their family status or capital.

Clearly there is no easy or universal solution to addressing problems of gender discrimination, particularly in relation to the labour market, which are reported by my participants. In Iran, movements such as WSCC, Bureau of Women's Affairs and Center for Women's Participation attempt to challenge gendered and patriarchal norms through feminist press, cinema etc. One way to do this might be to establish staff development in both university admissions and in government focused organisations aimed at improving the position of women in Iranian society (e.g. WSCC). But I also argue for the need to send articles directly to such organisations to highlight the evidence that gender discrimination in the labour market is a key reason that some female STEM graduates move abroad.

## 10.6 Limitations of the Study and Suggestions for Future Research

As with any research project there are a number of limitations to the findings I have reported on here which must be acknowledged and which also suggest possibilities for future research. Initially, I conducted this study to understand women's attitudes towards STEM subjects in HE in Iran. By using in-depth biographical interview as a method of data generation I was able to look closely at the meanings conveyed by my participants and how these draw on cultural models which draw on the Iranian context. This required 'thick descriptions' of the data and my interpretation of participants' utterances. However, this also meant that I could only use interview data from a small number of participants and therefore, I am not able to make any general claims about what it is like to study engineering or mathematics as a woman in Iran. I can only draw on what is recognised in the literature to be socially shared ideas and values and see how they are visible in this small data set. Future research therefore, might seek to establish a broader array of narratives from across a range of mathematics and engineering disciplines which might then be analysed thematically to establish general patterns of experience. This would require a much larger number of interviews and/or a more established survey which could collate students' views on a larger scale. In particular, it would be worthwhile asking questions which

directly relate to the cultural models I have highlighted in this thesis to establish stronger evidence regarding their important role.

In addition a comparative study of identity and participation in relation to STEM in Iran and a western context might be beneficial in establishing how these two contexts differ and the impact of this on women's narratives. The meaning of social status and capital exchange across two cultures such as these (western and middle-eastern) still remains unclear - I have tried to address this in part by considering what form capital takes in the Iranian situation - but it would be useful to compare forms of capital in order to show how they function differently in each context. Capital is somewhat broad in definition and can have different localised meanings in different cultures (Bourdieu, 1986). I have begun in this study to highlight what social prestige (status) might look like in the Iranian context but far more work is required to establish a more nuanced indication of this, which can help to provide the analytical generalisations (Yin, 2016). Literature such as Rodd et al. (2006), Hernandez-Martinez et al. (2008), William et al. (2016) and Black et al. (2016) claim that mathematics for many students is seen as a gate way to success which can lead them to a better future by 'providing insights into their defensive investments' (Rodd et al., (2006, p.35). However, according to Williams et al. (2016) and Black at al. (2016) science courses such as mathematics or physics may have an element of the 'cultural arbitrariness' attached to its capital (Bourdieu). Therefore, it would be useful to tease out what acts as the 'cultural arbitrary' element of engineering as capital in the Iranian context, and to distinguish this from knowledge and practices which also function as having 'use value' (Williams et al., 2016). This will require further in-depth qualitative work in the Iranian context which again might be a focus for future research.

## 10.7 Conclusion

As mentioned above, the findings of this research will be of interest to those who focused on increasing participation in both mathematics and engineering, but also those interested in women's empowerment more generally. The focus of this

research on localised forms of capital exchange in this context indicates that a different approach to increasing women's participation in mathematics and engineering might be appropriate compared with initiatives and approaches adopted in many western contexts (such as the UK e.g. Enterprising Science or WISE). Here, since engineering holds more capital than subjects such as mathematics and other sciences and since only some engineering subjects can be said to be male dominated - a more nuanced conversation about increasing participation is required. However, given the focus of this research and its emphasis on structural inequalities, it is difficult to make recommendations designed to change practices at a local level. Nevertheless, I hope that by giving voice to the women in this study and documenting their experiences of studying STEM in the Iranian context, I have generated findings which can inform future conversations which can challenge structural inequalities, not only in Iran but globally.

# REFERENCES


Abrahamian, E. (2008). *A history of modern Iran*. New York, NY: Cambridge, University Press.

Afkhami, A ( 2008). *The life and times of the Shah*. University of California Press.

Afkhami, M., & E. Friedl. (1994). *In the eye of the storm: Women in post-revolutionary Iran*. New York: Syracuse University Press.

Agar, M. and Hobbs, J.R. (1982) Interpreting discourse: coherence and the analysis of ethnographic interviews, *Discourse Processes*, 5, 1-32.

Aghajani, S., Khormaee, F., Rajabi, S & Rostamoqli khiavi, Z. (2012). The relationship of self-esteem and self-efficacy to mathematical anxiety in students. *Journal of School Psychology*, 1(3), 6-26 (in Persian).

Aghajanian, A & Thompson, V. (2013). Recent divorce trend in Iran. *Journal of Divorce & Remarriage*, 54(2), 112-125.

Alashloo, F., Castka, P., & Sharp, J. (2005). Towards understanding the impeders of strategy implementation in higher education (HE), a case of HE institutes in Iran. *Quality Assurance in Education,* 13(2): pp. 132-147.

AlSindi, N. (2013). Single-sex schooling and mathematics achievement in the middle-east: the case of Iran, Syria, Jordan, and Oman. Master's thesis. Georgetown University.

Anfara, V. A., Brown, K. M., & Mangione, T. (2002). Qualitative analysis on stage: Making the research process more public. *Educational Researcher*, 31(7), 28–36.

Ansary, N. (2013). The roots of feminist invocations in post-revolutionary Iran. PhD thesis, Columbia University.

Arani, A., Kakia, L & Karimi, V. (2012). Assessment in Education in Iran. *SA-eDUC JOURNAL*. 9(2).

Archer, L., Dewitt, J. & Wills, B. (2014). Adolescent Boys' Science Aspirations: Masculinity, Capital, and Power. *Journal of Research in Science Teaching*, 51 (1),1-30.

Archer, L., Dewitt, J., Osborne, J., Dillon, J., Wills, B., & Wong, B. (2012). Science aspirations, capital, and family habitus, how Families shape children's engagement and identification with science. *American Educational Research Journal*, 49 (5), 881-908.

Archer, L., J. DeWitt, et al. (2013). 'Not girly, not sexy, not glamorous': primary school girls' and parents' constructions of science aspirations1. *Pedagogy, Culture & Society,* 21(1): 171-194.

Archer, L., Osborne, J., Dewitt, J., Dillon, J., Wong, B., & Willis, B. (2013). *ASPIRES: Young People's Science and Career Aspirations: Age 10-14.* Kings College, London.

Ball, S (1994). *Education Reform: A critical and post-structural approach*. Buckingham: Open University Press.

Baron-Cohen, S. (2003). *The Essential Difference*. New York: Basic Books.

BBC News. (2014). The book in every Iranian home. [Internet]. Available from: http://www.bbc.co.uk/news/magazine-29648166. [Accessed 11/1/15].

BBC Persian News. (2011). Increasing women in university: Brain drain or brain gain. [Internet]. Available from: http://www.bbc.co.uk/persian/iran/2011/01/110115_ka_girls_university_konkor_iran.shtml. [Accessed 27/09/12].

BBC Persian News. (2012). Iranian university bans on women causes consternation. [Internet]. Available from: http://www.bbc.co.uk/news/world-middle-east-19665615 [Accessed 25/09/12].

BBC Persian News. (2012). Leaving educated women from Iran, Why? [Internet]. Available from: http://www.bbc.co.uk/persian/science/2013/03/130307_an_iran_students_brain_drain.shtml [Accessed 06/04/13].

BBC News. (2016). The engineering gap. [Internet].
Available from: https://www.bbc.co.uk/news/business-37254851. [Accessed 05/05/2017].

Behdad, S & Nomani, F. (2009). What a Revolution! Thirty Years of Social Class Reshuffling in Iran. *Comparative Studies of South Asia, Africa and the Middle East*, 29 (1), 84-104.

Belenky, M., Clinchy, B., Goldberger, N & Tarule, J. (1986). *Women's ways of knowing, The development of self, voice and mind*, BasicBooks, New York.

Black, L & Hernandez-Martin, P. (2016). Re-thinking science capital: the role of 'capital' and 'identity' in mediating students' engagement with mathematically demanding programmes at university. *Teaching Mathematics and Its Application.* 35(3), 131-143.

Black, L., Williams, J., Hernandez-Martin, P., Davis, P., Pampaka, M. & Wake, G. (2010). Developing a 'Leading Identity': the Relationship between Students' Mathematical Identities and their Career and Higher Education Aspirations. *Educational Studies in Mathematics*, 73, 55 – 72.

Black, L.; Williams, J. (2012). Contradiction and conflict between 'leading identities': becoming an engineer versus becoming a 'good Muslim' woman. *Educational Study in Mathematics* (2013). 84, 1–14.

Blaikie, N. (2000). *Designing Social Research: The Logic of Anticipation*. Cambridge: Polity Press.

Blickenstaff, J (2005). Women and science careers: leaky pipeline or gender filter? *Gender and Education.* 17(4), 369–386.

Bourdieu, P. (1977). *Outline of a theory of practice* (translated from the French by Richard Nice). Cambridge: Cambridge University Press.

Bourdieu, P. (1984). *Distinction: A Social Critique of the Judgment of Taste*. Cambridge: Harvard University Press.

Bourdieu, P. (1986). Forms of Capital. *Handbook of Theory and Research for the Sociology of Education* (J. Richardson Ed.) pp. 241–258). New York: Greenwood.

Bourdieu, P. (1991). *Language and Symbolic Power* (translated by G. Raymond & M. Adamson; edited by J. Thompson), Cambridge: Polity Press.

Bourdieu, P. (2001). *Masculine domination*. Cambridge, UK: Polity Press.

Bourdieu, P. (2010). *Sociology is a martial art*. NewYork, NY:New Press.

Bourdieu, P., & Passeron, J. (1990). *Reproduction in education, society and culture*. London: Sage.

Boyce, C & Neale, P (2006). Conducting in-depth interviews: A Guide for Designing and Conducting In-Depth Interviews for Evaluation Input, Monitoring and Evaluation, [Internet]. Available from: http://www.esfagentschap.be/uploadedFiles/Voor_ESF_promotoren/Zelfevaluatie_ESF-project/m_e_tool_series_indepth_interviews.pdf. [Accessed 23/12/12].

Braathe, H & Solomon, Y. (2014). Choosing mathematics: the narrative of the self as a site of agency. *Educational Studies in Mathematics.*

Brickhouse, N., Lowery, P.,&Schultz, K. (2000). *What Kind of a Girl Does Science? The Construction*, Cambridge, UK: Cambridge University Press.

Britannica. (2012). Mohammad Reza Shah Pahlavi. [Internet]. Available from: https://www.britannica.com/biography/Mohammad-Reza-Shah-Pahlavi. [Accessed 26/07/2017].

Bruner, J. (1986) *Actual minds, possible worlds*. Cambridge, MA: Harvard University Press.

Bruner, J. (1996). *The culture of education*. Cambridge: Harvard University Press.

Burton, D (2000). *Research training for social scientists*. London : Sage publications.

Busch, T. (1995). Gender diffrences in self-efficacy and attitudes toward computers. Journal *of Educational Compting Research*, 12, 147-158.

Carr, M., & Jessup, D. L. (1997). Gender differences in first-grade mathematics strategy use: Social and metacognitive influences. *Journal of Educational Psychology, 89*(2), 318-328.

Chaichian, M. (2011). The new phase of globalization and brain drain: Migration of educated and skilled Iranians to the United States. *International Journal of Social Economics*, 39(1), 18-38.

Choudhury, P. K. (2015). Growth of Engineering Education in India. *Higher Education for the Future*, 3(1): 93-107.

Choudry, S & Williams, J. (2017). Figured Worlds in the Field of Power. *Mind, Culture, and Activity*, 24 (3), 247-257.

Creswell, J. W. (2007). *Qualitative inquiry and research design: Choosing among five approaches*. London: Sage.

Cronin, S. (2005). *The making of modern Iran: state and society under Riza Shah*, 1921 - 1941. London: Routledge.

Crotty, M. (1998). *The foundation of social research*. London : Sage.

Denzin, N & Lincoln, Y. (2008). *Strategies of Qualitative Inquiry.* London: Sage.

Dewitt, J., Archer, L. & Osborne, J. (2013). Nerdy, Brainy and Normal: Children's and Parents' Constructions of Those who are Highly Engaged with Science. *Research in Science Education*, 43 (4), 1455-1476.

DfE (2015). Statistical First Release: Schools, Pupils, and their Characteristics. Department for Education. Available at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/219064/main_20text_20sfr122011.pdf. [Accessed 18/05/17].

Doris, A., O'Neill, D & Sweetman, O. (2103). Gender, single-sex schooling and maths achievement. *Economics of Education Review*, 35,104–119.

Eisenhardt, K.M. (1991). Better stories and better constructs: the case for rigor and comparative logic. *The Academy of Management Review*, 16: 620-62.

Entezarkheir, M. (2005). Why is Iran Experiencing Migration and Brain Drain to Canada? PhD Thesis, University of Waterloo.

Engineering UK, (2015). Synopsis, recommendations and calls for action. Th estate of engineering.

Epstein, D., Elwood, J., Hey, V., & Maw, J. (1998). Failing Boys? Issues in Gender and Achievement of School Science Identities. *Journal of Research in Science Teaching*, 37(5), 441–458.

Epstein , D., Mendick, H &Moreau, M (2010) Imagining the mathematician: young people talking about popular representations of maths, *Discourse:Studies in the Cultural Politics of Education*, 31(1), 45-60.

Etemad Moghadam, F. (2009). Undercounting women work in Iran. *Iranian Studies*, 42 (1), 82-95.

Fabes, R., Hayford, S., Pahlke, E, Santos, C., Zosuls, K., Martin, C & Hanish, L. (2014). *Peer influences on gender differences in educational aspiration and attainment.* Cambridge University Press. Cambridge.

Farrokhi, Y., Jamali, E., Yazdani, S., Monajemi, F., & Nedjat, S. (2012). The validity of Iran's national university entrance examination (Konkoor) for predicting medical students' academic performance. *BMC Med Education.* 12(60).

Farzanegan, M. (2011). Oil revenue shocks and government spending behaviour in Iran. *Energy Economics*, 33, 1055-1069.

Fielding, N., & Fielding, J. (1986). *Linking data*. Newbury Park, CA: Sage.

Flabbi, L. & M. Tejada. (2012). "Fields of Study Choices, Occupational Choices and Gender Differentials", background paper for the OECD Gender Initiative.

Fordham, S. (1993). Those Loud Black Girls: (Black) Women, Silence, and Gender "Passing" in the Academy. *Anthropology & Education Quarterly,* 24 (1), 3-32.

Frome , P., Alfeld , C., Eccles, J & Barber, B. (2006). Why don't they want a male-dominated job? An investigation of young women who changed their occupational aspirations, *Educational Research and Evaluation*, 12 (4), 359-372.

Gates, P. (2001). *Issues in Mathematics Teaching*. London: Routledge.

Gee, J. P. (2001). Identity as an analytic lens for research in education. *Review of*

Gomm, R., Hammersley, M., & Foster, P. (2000). *Case Study Method*. CA: Sage Publications.

Gupta, N. (2014). Rethinking the relationship between gender and technology: a study of the Indian example. *Work, Employment and Society,* 29(4): 661-672.

Harrison, F. (2006). Women graduates challenge Iran. BBC News. [Internet]. Available from: http://news.bbc.co.uk/1/hi/world/middle_east/5359672.stm [Accessed 5/08/2013].

Hashimi, S & Javadi, M (2012). Structural functionalism in increasing women in universities. *Central of women study in university of Tehran*. 113-126.

Hernandez-Martinez, P., Black, L., Williams, J., Davis, P., Pampaka, M., & Wake, G. (2008). Mathematics students' aspirations for higher education: class, ethnicity, gender and interpretative repertoire styles. *Research papers in Education*, 23(2), 153-165.

Holland, D., Lachicotte, W., Jr., Skinner, D., & Cain, C. (1998). *Identity and agency in cultural worlds*. Cambridge: Harvard University Press.

Hubbard, L & Datnow, A. (2005). Do Single-Sex Schools Improve the Education of Low-Income and Minority Students? An Investigation of California's Public Single-Gender Academies. *Anthropology & Education Quarterly,* 36 (2), 115-131.

Human Right Watch. (2012). Iran: Ensure Equal Access to Higher Education. [Internet]. Available from: http://www.hrw.org/news/2012/09/22/iran-ensure-equal-access-higher-education [Accessed 04/11/12].

Hyde, J. (1996). Meta-analysis and the psychology of gender differences, Journal of Women in Culture and Society, 16 (1), 55-73.

Institute for Research and Planning in Higher Education (IRPHE). (2012). Higher education in Iran. A national report. Tehran, Iran.

Iran Statistical Center. (2016). Report of the Selection of Labor Force Survey Results. Tehran, Iran: Iran Statistical Centre.

Iran Economic Monitor. (2106). Iran Economic Monitor, Towards Reintegration. World Bank Group.

Jacque, W. (1976). *Iran: Past, Present and Future*. Aspen for humanistic studies. New York.

Kerr, K. (2012). EDUC60500 Planning of research course unit hand out, University of Manchester, Manchester.

Khavar, F., & Ghaneye, M. (2006). A Study on the Cultural Factors Influencing the Increase in Girl's Entrance into Universities. *Women in Development & Politics*, 4(4), 115-13. (in Persian).

Kiamanesh, A. R . (2004). Factor affecting Iranian students' achievement in mathematics. In org/download/ieahq/IRC2004/kiamanesh.pdf (in Persian).

Koolaee, E. (2014). The Impact of Iraq-Iran War on Social Roles of Iranian Women, *Middle East Critique*, 23 (3), 277-291.

Kuzmak, N. (2010). Women Engineers: Stories of persistence. PhD thesis, Capella University. United State.

Lee, S., Niederle, M & Kang, N. (2014). Do single-sex schools make girls more competitive? *Economics Letters*, 124, 474–477.

Lielblich, A., R. Tuval –Mashiach&T.Zilber (1998). *Narrative research: Reading, analysis and interpretation.* London: Thousand Oaks & New Delhi, Sage.

Link, S. (2012). Single-Sex Schooling and Student Performance: Quasi-Experimental Evidence from South Korea, *Ifo Working Paper*, 146.

Lutz, W., Cuaresma, J. C., & Abbasi-Shavazi, J. (2010). Demography, education, and democracy: Global trend and the case of Iran. *Population and Development Review*, 36, 253–281.

MacPhee, D., S. Farro, et al. (2013). Academic Self-Efficacy and Performance of Underrepresented STEM Majors: Gender, Ethnic, and Social Class Patterns. *Analyses of Social Issues and Public Policy,* 13(1): 347-369.

Mahdi, A. (2004). The Iranian Women's Movement: A Century Long Struggle. *The Muslim World*, 94, 427-445.

Marx. (1976). *Capital, A Critique of Political Economy.* Progress Publishers, Moscow, USSR.

McCabe, A & Peterson, C. (1991). *Developing narrative structure*. LEA: New Jersey.

Mehr News, (2012). Admission removed 36 girls from 77 disciplines of engineering / delete record. [Internet]. Available from: http://www.mehrnews.com/fa/newsdetail.aspx?NewsID=1666033 [Accessed 25/11/2012]

Mehran, G. (1991). The Creation of the New Muslim Woman: Female Education in the Islamic Republic of Iran, *Convergence.* 24 (4), 42–52.

Mehran, G. (1999). Lifelong Learning: New Opportunities for Women in a Muslim Country (Iran). *Comparative Education*, 35(2), 201-215.

Mehran, G. (2003). The Paradox of Tradition and Modernity in Female Education in the Islamic Republic of Iran. *Comparative and International Education society*. 47(3), 269-286

Menashiri, D. (2001). *Post-Revolutionary politics in Iran,* Frank Cass: London.

Mendick, H. (2005a). A beautiful myth? The gendering of being/doing "good at maths". *Gender and Education,* 17(2), 203–219.

Mendick, H. (2005b). Mathematical stories: why do more boys than girls choose to study mathematics at AS level in England? *British Journal of Sociology of Education*, 26(2), 225–241.

Mendick, H. (2006). *Masculinities in mathematics*. Berkshire: Open University Press.

Moghadam, V.M. (2003). *Modernizing women: Gender and social change in the Middle East*. Boulder, CO: Lynne Rienner Publishers.

Moghadam, V.M. (2004). Iran after 25 years of revolution: A retrospective and a look ahead. Conference paper.

Moreau, M., Mendick, H & Epstein, D. (2010. Constructions of Mathematicians in Popular Culture and Learners' Narratives: A Study of Mathematical and Non-Mathematical Subjectivities, *Cambridge Journal of Education,* 40 (1), 25-38.

Moaddel, M. (1993). *Class, politics and Ideology in the Iranian Revolution*. Columbia University Press. New York.

Myers, M. D. & Newman, M. (2007). The Qualitative Interview in IS Research: Examining the Craft. *Information and organization,* 17(1), 2-26.

Najmabadi, A. (1998). Crafting an educated housewife in Iran, Remarking women: feminism and modernity in the Middle East, 91-125.

Najmabadi, A. (2000). (Un)Veiling Feminism, *Social Text,* 18 (3), 29-44.

Nejat, P., Hatami, J. (2012). Influenceability by gender-major stereotypes in occupational choice: The distinction between math-engineering and humanities university students, *Quarterly Journal of Applied Psychology*, 22, 107-122. (In Persian).

Nejat, P., Pournaghash Tehrani, S. S. & Hatami, J. (2011). Gender stereotypes related to different academic fields among Iranian university students, *Social Psychology Researc*h *Quarterly*, 3, 1-18. (In Persian).

Nomani, F & Behdad, S. (2006). *Class and Labour in Iran, Did the Revolution matter?* Syracus University Press. New York.

Norouzzadeh, R & Mehrparvar, M. (2010). *A national report of higher education in Iran 2009-2010.* Institute for Research and Planning in Higher Education (IRPHE): Tehran.

NSF, (2018). National Science Foundation, where discoveries begin. [Internet]. Available from: https://www.nsf.gov/statistics/states/ [Accessed 30/06/2018].

O'Connor-Petruso, S & Miranda, K. (2004). Gender inequities among the top scoring nations, Singapore, Republic of Korea, and Chinese Taipei, in mathematics achievement from the TIMSS-R study. S.U.N.Y College at Old Westbury, USA.

OECD, (2018). Members and partners. [Internet]. Available from: http://www.oecd.org/about/membersandpartners/ [Accessed 24/02/2018].

OECD, (2015). *Education at a Glance 2014*: OECD Indicators, OECD Publishing.

Oakley, A. (1981). Interviewing women: A contradiction in terms. In H. Roberts (Ed.), *Doing feminist research.* London: Routledge & Kegan Paul. 30-61.

Patton, M. Q. (2002). *Qualitative evaluation and research methods* (3rd ed.). Thousand Oaks, CA: Sage Publications, Inc.

Paivandi, S. (2008). Education in the Islamic Republic of Iran and Perspectives on Democratic Reforms. *Legatum Institute's workshop,* The Future of Iran' project: Educational Reform.

Pajares, F. & Miller, M. D. (1997). Mathematics Self-efficacy and Mathematical Problem Solving: Implications of Using Different Forms of Assessment. *The Journal of Experimental Education*, 65 (3), 213-228.

Pampaka, M., Kleanthoys, I., Hutcheson, G. D., & Wake, G. (2011). Measuring Mathematics Self-efficacy as a Learning Outcome. *Research in Mathematics Education,* 13 (2), 169-190.

Parker, A &Tritter, J. (2006). Focus group method and methodology: current practice and recent debate. 29 (1), 23-37.

Povey, T & Rostami-Povey, E. (2012). *Women, power and polotics in 21st century Iran.* Ashgate Publishing Limited, Surrey.

Reay, D., Davies, J., David, M., & Ball, S. (2001). Choices of Degree or Degrees of Choice? Class, 'Race' and the Higher Education Choice Process. *Sociology,* 35 (4), 855–874.

Reeves, M. 1980. *Female warriors of Allah: women and the Islamic revolution*. New York: E.P. Dutton.

Rezaee, R (2008). Education behind the veil: The impact of the cultural revolution on women's higher education in Iran. PhD thesis. San Marco University. Texas.

Rezaei, A. (2012). Can self-efficacy and self-confidence explain Iranian female students' academic achievement? *Gender and Education*, 24 (4), 393-409.

Rezaei-Rashti, G. (2011). Iranian Women's Increasing Access to Higher Education but Limited Participation in the Job Market. *Middle East Critique*, 20(1), 81-96.

Rezaei-Rashti, G. (2012). Women and education in the Islamic Republic of Iran: Repressive Policies, Unexpected Outcomes. *The Legatum Institute Workshop*. The Future of Iran' project: Educational Reform.

Rodd, M., & Bartholomew, H. (2006). Invisible and special: young women's experiences as proceedings of the IRC-2004 TIMSS Vol 1 (ed) C.Papanastasiou. Cyprus University, Nicosia.

Rokis, R. (2011). Islam and modernity: a case of Muslim female engineers in Malaysia. *Journal of Islam in Asia*, 2, 402-420.

Rostami-Povey, E. (2010). *Iran's influence: a religious-political state and society in its region.* Zed Books Ltd. London.

Sadker, M. & Sadker, D. (1994). *Failing at fairness: how our schools cheat girls.* New York: First Touchstone edition.

Saed-Zadeh, H & Hejazi, E. (2014). The relation between self-efficacy beliefs and dynamic self with mathematics achievement among secondary school students in Sardasht city. *Training & Learning Researches,* 4.

Sakurai, K. (2004). University entrance examination and the making of an Islamic society in Iran: a study of the post-revolutionary Iranian approach to "konkur". *Iranian Studies.* 37(3): 385-406.

Salehi-Isfahani, D. (2013). The Future of the Iranian Labour Market: Demography and Education. *Legatum Institute's workshop*, The Future of Iran' project.
Sax, L. (2001). Undergraduate Science Majors: Gender Differences in Who Goes to Graduate School. *The Review of Higher Education.* 24(2). 153-172.

Seifert, A., Schools, C & Pugalee, D. (2009). Single Sex Mathematics Classes: A Critical Analysis of the Impact at a Secondary School. Project on single-sex schooling.

Sfard, A. & Prusak, A. (2005). Telling identities: in search of an analytic tool for investigating learning as a culturally shaped activity. *Educational Researcher,* 34(4), 14–22.

Shank, G. (2002). *Qualitative research: A personal skills approach*. Upper Saddle River, NJ: Merrill Prentice Hall.

Shapka, J., Domene, J & Keating, D. (2006). Trajectories of career aspirations through adolescence and young adulthood: early math achievement as a critical filter. *Educational Research and Evaluation*, 12 (4), 347-358.

Sharifi Saki, S., Fallah, M., Zareei Mahmoodabadi, H & Karimi, R. (2014). The Comparative Analysis of Mathematical Achievement, Self-Efficacy, and Self-Concept Based on the Perceived Classroom Climate Among Male and Female Students. *Int J School Health*, 1(3).

Shashaani, L. (1997). Gender differences in computer attitudes and use among college students. *Educational Computing Research*. 16 (1), 37-51.

Shashaani, L & Khalili, A. (2001). Gender and computers: Similarities and differences in Iranian college students' attitudes toward computers. *Computers & Education*, 37(3-4), 363-375.

Shavarini, M.K. (2006). The role of higher education in the life of a young Iranian woman. *Women's Studies International Forum*, 29 (1), 42-53.

Shaw, E & Barbuti, S. (2010). Patterns of Persistence in Intended College Major with a Focus on STEM Majors. *NACADA Journal.* 30 (2), 19-31.

Sheldrake, R., Mujtaba, T & Reiss, M. (2015). Students' intentions to study non-compulsory mathematics: the importance of how good you think you are. *British Educational Research Journal*, 41(3), 462-488.

Smith, A & Dengiz, B. (2010). Women in engineering in Turkey_a large scale quantitative and qualitative examination. *European Journal of Engineering Eucation*. 35 (1), pp 45-57.

Smith, P. (2014). *Hafez book of divination*. Australia: Book Heaven.

Solomon, Y. (2007). Not belonging? What makes a functional learner identity in the undergraduate mathematics community of practice? *Studies in Higher Education*, 32(1), 79-69.

Solomon, Y. (2012). Finding a voice? Narrating the female self in mathematic. *Education Study Mathematics.* 80:171–183.

Solomon, Y., Lawson, D., & Croft, A. (2011). Dealing with "fragile identities": Resistance and refiguring in women mathematics students. *Gender and Education*, 23(5), 565–583.

Solomon, Y., Radovic, D. & Black, L. (2016). "I can actually be very feminine here": contradiction and hybridity in becoming a female mathematician. *Educational Studies in Mathematics*, 91 (1), 55-71.

Sonnert G, Holton G (1995b). *Who Succeeds in Science? The Gender Dimension*. New Brunswick. NJ: Rutgers University Press.

Stinson, D. (2004). Mathematics as "Gate-Keeper" (?): Three Theoretical Perspectives that Aim Toward Empowering All Children With a Key to the Gate. *The Mathematics Educator*, 14 (1) 8–18.

Bertelsmann Stiftung. (2016). BTI 2016 — Iran Country Report. Gütersloh: Bertelsmann Stiftung.

Tabnak News. (2012). [Internet]. Available from: http://www.tabnak.ir/fa/social. Accessed [17/07/2013].

Tahmasebi, A (2011), Concettualizzazione della modernità in Iran nell'era Pahlavi (Conceptualization of modernisation in Iran during Pahlavi era). University of Rome. Phd Thesis.

The Guardian. (2015). Iran earns more from tax than oil for first time in almost 50 years [Internet]. Available from: https://www.theguardian.com/world/2015/sep/27/iran-tax-oil-first-time-50-years. [Accessed 21/07/17].

The Guidance Booklet. (2012). The Guidance Booklet Of Selecting Course, Iran: Science Ministry Publication.

The Institute for Research and Planning in Higher Education (IRPHE), [Internet]. Available from: https://irphe.ac.ir/find.php?item=1.572.256.en&slct_pg_id=572&sid=1&slc_lang=en, [Accessed 24/10/2017].

The Telegraph. (2012). Anger as Iran bans women from universities. [Internet]. Available from: http://www.telegraph.co.uk/news/worldnews/middleeast/iran/9487761/Anger-as-Iran-bans-women-from-universities.html [Accessed 27/9/12].

TIMSS. (2015). TIMSS 2015 International Results in Mathematics. International Study Centre, Boston College.

TIMSS. (2007). TIMSS 2007 Technical Report. International Study Centre, Boston College.

TIMSS. (2003). TIMSS 2003 International Mathematics Report. International Study Centre, Boston College.

Torbat, A. E. (2002). The Brain Drain from Iran to the United States. *Middle East Journal*, 56 (2), 272-295.

UNESCO. (2013). IGU/UNESCO Roundtable on Women in Engineering Concept paper. [Internet]. Available from: http://www.unesco.org/new/fileadmin/MULTIMEDIA/HQ/SC/pdf/IGU_UNESCO_Roundtable_on_Women_in_Engineering_Concept_Note.pdf. [Accessed 23/04/14].

UNESCO. (2013). *UNESCO Country Programming Document (UCPD) for the*
United Nation (2005). Science, Technology and Innovation Policy Review, The Islamic Republic of Iran, United Nation Conference on Trade and Development.

Vahidnia, V. (2007). Case study: fertility decline in Iran. *Popul Environ*, 28, 259–266.

Opendemocracy. (2012). Iran, women in the frame. [Internet]. Available from: opendemocracy.net/ sanam-vakil/iran-women-in-frame. Accessed [20/09/2013].
Walkerdine, V. 1998. *Counting girls out.* 2nd ed. London: Falmer.

Walkerdine, V. (1998). *Counting girls out, girls and mathematics*. London: UK Falmer Press.

Wengraf, T. (2004). The Biographic-Narrative Interpretive Method (BNIM)-Shortguide. November 2004. version 22.

Wengraf, T. (2006). Interviewing for life-histories, lived situations and personal experience: The Biographic-Narrative Interpretive Method (BNIM). Shortest Short Guide to BNIM interviewing and interpretation. August 2006. version 6.8.

White, D. (2014). How are the career related decisions of young people from disadvantaged backgrounds shaped during their transition towards the end of compulsory schooling? PhD thesis, The University of Manchester. Manchester.

Williams, J. & Choudry, S. (2016). Mathematics Capital in the Educational Field: Bourdieu and Beyond. *Research in Mathematics Education,* 18 (1), 3-21.

Williams, J et al. (2008). Keeping Open the Door to Mathematically-Demanding F&HE Programmes: Full Research Report, ESRC End of Award Report, RES-139-25-0241. Swindon: ESRC.

Williams, J. (2011). Teachers telling tales: the narrative mediation of professional identity, *Research in Mathematics Education*, 13(2), 131-142.

Williams, J. (2011). Toward a Political Economic Theory of Education: Use and Exchange Values of Enhanced Labor Power. *Mind, Culture, and Activity*, 18(3), 276-292.

Williams, J. (2012). Use and Exchange Value in Mathematics Education: Contemporary CHAT Meets Bourdieu's Sociology. Educational Studies in Mathematics, 80 (1-2), 57-72.

Williams, J. S., Black, L., Hernandez-Martinez, P., Davis, P., Pampaka, M., & Wake, G. (2009). Repertoires of Aspiration, Narratives of Identity, and Cultural Models of Mathematics in Practice. *Social interactions in multicultural settings* (M. César & K. Kumpulainen Eds.) pp. 39–69. Rotterdam, The Netherlands: Sense.

WISE. (2016). Women in Science, Technology, Engineering and Mathematics: from Classroom to Boardroom. UK Statistic.

Yin, R.K. (2016). *Qualitative Research from Start to Finish.* Second Edition. New York: The Guilford Press.

# Appendices

## **Appendix 1:** Women's Social and Cultural Council (WSCC) (Supreme Council of Cultural Revolution). Source Information: http://www.salamiran.org/Women/Organisations/wscc.html

The WSCC came into existence in accordance with the decision of the 115th Session of the Supreme Council of Cultural Revolution, on June 9th 1987, under its supervision. It was formed in order to make policies regarding the socio-cultural affairs of women and take necessary steps for the fulfilment of its objectives. WSCC's objectives are briefly as follows:

1. The adoption of necessary policies to pave the way for the growth of women's personality, restitution of their human values and dignity and ensure all-inclusive rights according to Islamic laws.
2. Examination of the ways and means of women's participation in political, social, cultural and artistic activities and removal of the existing barriers.
3. Preparation of plans for strengthening the sacred institution of the family and safeguarding its sanctity.
4. Adoption of necessary policies in order to identify and fight corrupt foreign influences and eliminate fossilized outlooks from the society.
5. Adaption of plans for the best use by girls and women of their leisure time.
6. Preparation of plans for promotion of women's general knowledge and literacy, and adoption of proper methods for their education and higher education.
7. Preparation of suitable plans for solving the problems of unprotected women.
8. Coordination of the activities of centers and organizations working on women's sociocultural affairs.
9. Preparation of plans for the development of cultural links with women's societies and revolutionary movements of the world, especially in Muslim countries.
10. Presentation of proposals and plans to the Supreme Council of Cultural Revolution, regular evaluation of women's social and cultural status and submission to competent centres, proposals for research on women's important social and cultural issues.

## **Appendix 2:** Mehran's (2003, p.275) Summary of the Plan for the General System of Education in the Islamic Republic of Iran in 1988

The key aims of this Education Plan was to assign different roles and responsibilities for boys and girls and make clear distinctions early in their lives while trying to empower young girls and women in the field of education. The Education Plan illustrates the expectations that the authorities of the Islamic Republic have of female members of society, as expressed in the following principles:

1. The Iranian educational system should recognize the identity of a woman and her role in the family and the society on the basis of Islam and plan for the content and method of her schooling accordingly.
2. The educational guidance of girls should be based on their capabilities and interests, and their vocational guidance should take into consideration the kinds of occupations needed by women, best fulfilled by women, or most fit with their role and responsibility in the family.
3. Education in Iran should strengthen the social and political insight of girls and increase their self-confidence in fulfilling their social and family responsibilities.
4. Curriculum development in Iran should emphasize the sanctity and stability of the family and introduce the different roles of men and women in marital life.
5. The system of education should take into consideration the unique characteristics of boys and girls at the age of 7 and send female teachers to girls' schools and male teachers to boys' schools.
6. The Ministry of Education should eliminate any form of discrimination against girls, especially in rural areas and among nomads, and give priority to girls in the distribution of resources and opportunities.
7. In order to encourage married women to continue their education, special schools should be created, educational radio and television should be provided, correspondence education should be encouraged, and day-care centers should be provided for their children.
8. Women should participate in the planning, policy making, management, and administration of education at all levels, especially at the top-level positions[18].

[18] Paraphrased from Ministry of Education, Islamic Republic of Iran, Tarh-e kolliyat-e nezam amuzesh va parvaresh-e jomhuri-ye Islami Iran (The plan for the general system of education in the Islamic Republic of Iran) (Tehran: Council of Fundamental Transformation in the System of Education, 1988), pp. 57, 64–66, 72–73, 82

## Appendix 3: Mehran's Summary of the 2001 National Report on Women's Status in the Islamic Republic of Iran[19]

The key aims of the report were to encourage female students to participate in STEM and management areas and to eliminate the traditional perspective about women and their participation in STEM as summarised below by Mehran (2003, P. 284):

- Increase the self-confidence and raise the cultural awareness of school and college girls.
- Emphasize the participation of women specialists in planning and policy making at all levels of education.
- Develop and promote counselling services in high schools to prepare and guide students toward more appropriate fields of study in order to eliminate the concentration of female university students in certain majors.
- Determine a particular quota for creating equal opportunities for women in a number of specific university majors.
- Reduce gender gaps in the fields of science, mathematics, and applied sciences.
- Remove limitations for girls' participation in the agricultural disciplines.
- Teach management skills to women with the aim of enhancing their participation in the sphere of decision-making.
- Expand and diversify technical and vocational training programs for women with a view to creating employment opportunities.
- Establish courses on women's studies at universities for the purpose of eliminating incorrect traditional perceptions about women.
- Modify educational materials in order to portray the correct image of women's roles in the family, society, and education, and of the mutual rights of women, men, and the family at all levels.

[19] Paraphrased from Center for Women's Participation, Office of the President, *National Report on Women's Status in the Islamic Republic of Iran* (Tehran:Center for Women's Participation, 2001), pp. 15, 17–19.

# **Appendix 4:** Number of Female and Male Students in Mathematics, Electrical and Computer Engineering at Jesus University

**Table 9**: Number of female and male students in the field of mathematics between 2009 and 2014

| Year of study | 2009-2010 | 2010-2011 | 2011-2012 | 2012-2013 | 2013-2014 | 2014-2015 |
|---|---|---|---|---|---|---|
| Number of female students | 48 | 41 | 40 | 21 | 21 | 20 |
| Number of male students | 24 | 14 | 22 | 31 | 13 | 17 |
| Total | 72 | 55 | 62 | 52 | 34 | 37 |

**Table 10**: Number of female and male students in the field of computer-software engineering between 2009 and 2014

| Year of study | 2009-2010 | 2010-2011 | 2011-2012 | 2012-2013 | 2013-2014 | 2014-2015 |
|---|---|---|---|---|---|---|
| Number of female students | 29 | 33 | 28 | 25 | 25 | 17 |
| Number of male students | 18 | 40 | 38 | 44 | 20 | 24 |
| Total | 37 | 73 | 66 | 69 | 45 | 43 |

**Table 11:** Number of female and male students in the field of computer-hardware engineering between 2009 and 2015

| Year of study | 2009-2010 | 2010-2011 | 2011-2012 | 2012-2013 | 2013-2014 | 2014-2015 |
|---|---|---|---|---|---|---|
| Number of female students | 20 | 31 | 32 | 24 | 19 | 8 |
| Number of male students | 23 | 23 | 47 | 31 | 24 | 20 |
| Total | 43 | 54 | 79 | 55 | 43 | 28 |

**Table 12**: Number of female and male students in the fields of electrical-electronic engineering between 2009 and 2013

| Year of study | 2009-2010 | 2010-2011 | 2011-2012 | 2012-2013 | 2013-2014 |
|---|---|---|---|---|---|
| Number of female students | 16 | 18 | 20 | 17 | 13 |
| Number of male students | 37 | 36 | 25 | 19 | 37 |
| Total | 53 | 54 | 45 | 36 | 50 |

**Table 13**: Number of female and male students in the field of electrical-communication engineering between 2009 and 2013

| Year of study | 2009-2010 | 2010-2011 | 2011-2012 | 2012-2013 | 2013-2014 |
|---|---|---|---|---|---|
| Number of female students | 17 | 21 | 12 | 12 | 12 |
| Number of male students | 24 | 27 | 25 | 17 | 23 |
| Total | 43 | 48 | 37 | 29 | 35 |

**Table 14**: Number of female and male students in the field of electrical-power engineering between 2009 and 2012

| Year of study | 2009-2010 | 2010-2011 | 2011-2012 | 2012-2013 |
|---|---|---|---|---|
| Number of female students | 2 | 7 | 13 | 12 |
| Number of male students | 34 | 46 | 25 | 21 |
| Total | 36 | 55 | 38 | 33 |

## Appendix 5: My Story

### Personal experience

Until I was eighteen, I lived in an urban area of Iran which is called Y city. I have vague memories of my school times before going to university. The most anxious time I experienced was during the war and I have no good memories from my time spent in elementary school, as my education was interrupted by the focus of the war. The school was closed about two years and my understanding of the world at this time was facilitated by programmes on TV. I clearly remember how such programmes communicated messages about cultural values and the interests of the country such as 'from the blood of martyr thousand of blossom will grow up'. After the war was over, the Iranian new teaching context seemed to provide us women with a new future. We were the 'generation of war' and I grew up learning that, as a woman, I should 'fight with education' rather than weapons. The end of the war opened the way to an age of hope, where we could imagine and view a new country.

When the war finished, I had almost completed elementary school. As I grew older and entered into my teenage years, I experienced typical teenage problems such as resisting authority within the home and school. For instance, I wanted to go out with friends but my parents did not permit this. For these reasons I experienced lots of trouble with school and my family. For example, school teachers regularly checked my bag for makeup etc. and my parents restricted my access to the phone. Although at the same time, socially, going to school was the best part of my life. Socialising and communicating with friends was one of my greatest pleasures at school, as it was not easy to do this at home or in wider society. At high school I selected a mathematics and physics programme. This was chosen because I had an ambition to study engineering at university because I believed it had high social status and would be much easier than studying medicine. However, when I sat the university exam I did not meet the criteria for engineering and ended up studying mathematics in a rural university. I did not achieve high enough grades to study engineering at a prestigious university and I felt disappointed with this but consoled myself with the fact that I still had a university place. In addition, it appeared my family was a little disappointed too, since many of their neighbours' children had succeeded in engineering.

My time at university changed my whole life; it was the best part of my life and it felt like living a miracle. As a mathematics student on a programme dominated by girls, I found myself living in accommodation with six others girls who all had the same feeling about university. All of us had failed to get our first choice degree programme in engineering but found that studying mathematics gave us freedom which we had never experienced before: we could go out together, we could travel together and we could laugh together. I enjoyed every second of it and, for about three years, I benefitted from this space where I could be creative, discuss different issues with my friends, and reflect on my emotion and those of others. But, when my university time finished, all the depression of life came back as I returned home to family life, where my social activities were once again restricted. I felt like I had woken up from my good dream.

I later started to broaden my concern with notions of diversity. I wanted to learn more about other cultures and languages in privileged countries. Therefore, I applied to study English in the UK and I was accepted by Leeds Metropolitan University to study an English course. Moving to the UK was the biggest change of my life. At that moment, I faced a new context, a new school and no friends. I could not easily adapt myself with my new environment, my English language was very poor compared with students from other nations and I started to feel the sensation of not belonging there. I attempted to leave these feelings behind by learning the language and trying to adapt myself to the new culture. I continued to feel as if I belonged nowhere and this gave me the motivation to think about 'what makes a country successful' as I was always telling myself 'this country is beautiful but it is not my homeland'.

This process started from understanding the 'economy of industrial countries' and my master thesis looked at 'how to be independent from oil dependency'. Studying my master's again gave the sensation of belonging somewhere and once more I felt I was studying with my friends in Iran. Beside university life, at this stage I have also marriage life which I should talk about now. I got married as soon as I moved to the UK, so I have university and marriage life both together. After finishing my master's, I was thinking I should leave academic study behind and concentrate more on marriage life. But normal life did not really interest me and imagining life without university was really painful. Therefore, I decided to continue my study as a PhD student (however, during this study I got divorced). So now I am studying for my PhD at the University of Manchester where I am researching the experiences of female students who wish to pursue a career in mathematics and engineering in Iran. I am hoping we can achieve the moment where we

can focus more on human capital rather than natural resources, as natural resources will end one day and the country needs assistance to maximise its full potential. I believe that, with remnants of the past and with aspiration for the future, we can imagine a new country with a better place to live.

## **Appendix 6:** The Survey

The survey is exploratory and will ask open ended questions regarding your choice of degree programme, your experience of studying at university and your aspirations for the future. You will have 15 minutes to complete it. Please note that by completing this survey you agree that your responses can be used as part of the research project outlined on the information sheet and at the information giving meeting. You are free to withdraw from this study at any time up until July 2015 when the data will be anonymized for analysis.

Please write your answer below. Feel free to avoid any questions that you do not want to answer. I would really appreciate your consideration.

Name: _____

Home Town: _____ _

Mom's highest level of education and occupation:

Dad's highest level of education and occupation:

Highest level of education you want to attain in what subject:

Career Goals:

Course title:

Year of study:

1. What were the main reasons you chose your university subject to study at university?
2. Has your experience at university been positive or negative? Why?
3. What do you hope to do after your university degree have been completed?
4. If you had to make a movie of your life, what would be the title of the movie? Why?
5. If you have any other thoughts/issues that you would like to be considered please write it here?

# Appendix 7: Information Sheet and Consent Form

An Exploration of Female Students' Choices, Experiences and Future Aspirations of Studying Undergraduate Mathematics and Engineering Programmes in Iran

**Participant Information Sheet**

You are being invited to take part in a research study because you are Iranian female students who studies mathematics and engineering programme in Iran. Before you decide it is important for you to understand why the research is being done and what it will involve. Please take time to read the following information carefully and discuss it with others if you wish. Please ask if there is anything that is not clear or if you would like more information. Take time to decide whether or not you wish to take part. Thank you for reading this.

**Who will conduct the research?**

The research will be conducted by myself, Nooshin Jahangiri, as part of my PhD in Education at the University of Manchester in the UK.

**Title of the Research**

An Exploration of Female Students' Choices, Experiences and Future Aspirations for Studying Undergraduate Mathematics and Engineering Programmes in Iran.

**What is the aim of the research?**

The aim of this study is to explore why women have enrolled on mathematics and engineering courses at universities in Iran in increasing numbers over the past 30 years. Iran is unusual when compared to many western countries in terms of participating more female students in to mathematics and engineering programme. Therefore, the aim of this study is to look at why and how this increasing level occurs. I will attempt to understand this situation by asking female students why they have chosen their specific degree programme, how they have found the experience of studying and what their future ambitions are after graduation.

**Why have I been chosen?**

There will be 15 female students recruited for this study in total. I am asking you to take part because you are Iranian female students who studies mathematics and engineering at university in Iran.

**What would I be asked to do if I took part?**

If you choose to take part in research, you will be asked to tell me about your life story through a semi-structured biographical interview which will take place in 2 phases. In the 1st interview I will ask you a generic question about how you came to be a student studying mathematics or engineering at Jesus University. Then I will ask some more questions to enquire you about your choice of degree programme, your experience at university and your future aspirations. I will then use this information to build a narrative or life story about you which will be the focus of our discussion in the 2nd interview. At this point you can change the narrative or confirm it and maybe even develop it further.

**What happens to the data collected?**

I will transcribe and analyse the data. The data will enable me to know why female student in Iran are motivated to choose mathematics and engineering programme while women in many other countries are not interested in such a programme. Your data will be used for the completion of my PhD dissertation to be submitted to the Manchester Institute of Education at the University of Manchester.

**How is confidentiality maintained?**

The interviews will be conducted in a location which ensures that what you say cannot be heard by anyone but myself (i.e. a quiet location on campus, away from your department). The interviews will be audio recorded and transcribed and all the data will be anonymised so that you cannot be identified by someone reading it - I will also anonymise any other information such as geographical locations and the names of other people you may wish to refer to in your interviews.

As outlined above, after the first interview I will use your data to construct a story which tries to capture your life and experience as a student. I will send this to you to check whether you feel the information captured is accurate and we will discuss this in the 2nd interview. Therefore, none of this data will be used in the research unless you are happy with it. You can stop the interview at any point and you do not need to answer any questions that you do not like or that you feel uncomfortable about.

**What happens if I do not want to take part or if I change my mind?**

It is up to you to decide whether or not to take part. If you do decide to take part you will be given this information sheet to keep and be asked to sign a consent form. If you decide to take part you are still free to withdraw at any time without giving a reason.

**Will I be paid for participating in the research?**

No payment will be required for this research.

**What is the duration of the research?**

We will meet to conduct the interviews at two separate points in time at a date, time and venue which is convenient to you. This research will take place between March 2015 and May 2015. If you agree to participate, the interviews will last up to an hour each time. Usually interviews will last between thirty and forty five minutes, but an hour is allowed in case the time is needed.

**Where will the research be conducted?**

The interview will take a place in a quiet public space on campus away from other students - this may be in either the public grounds of the university (outside) or in a small teaching room away from your department.

**Will the outcomes of the research be published?**

The outcomes of the research may be published in academic journals, conference proceedings and in the form of PhD thesis.

**Criminal Records Check (if applicable)**

Not applicable.

**Contact for further information**

I can be reached by email at nooshinjahangiri@postgrad.manchester.ac.uk or by calling the number I will be given to you when I meet you. You can also contact my supervisor Dr Laura Black (laura.black@manchester.ac.uk).

**What if something goes wrong?**

If there are any issues regarding this research that you would prefer not to discuss with members of the research team, please contact the Research Practice and Governance Co-ordinator by either writing to 'The Research Practice and Governance Co-ordinator, Research Office, Christie Building, The University of Manchester, Oxford Road, Manchester M13 9PL', by emailing: Research-Governance@manchester.ac.uk, or by telephoning 0161 275 7583 or 275 8093

MANCHESTER 1824

The University of Manchester

An Exploration of Female Students' Choices, Experiences and Future Aspirations of Studying Undergraduate Mathematics and Engineering Programmes in Iran

**CONSENT FORM**

If you are happy to participate please complete and sign the consent form below

| | **Please Initial Box** |
|---|---|
| 1. I confirm that I have read the attached information sheet on the above study and have had the opportunity to consider the information and ask questions and had these answered satisfactorily. | |
| 2. I understand that my participation in the study is voluntary and that I am free to withdraw at any time without giving a reason. | |
| 3. I understand that the interviews will be audio -recorded | |
| 4. I agree to the use of anonymous quotes | |
| 5. I agree that any data collected may be published in anonymous form in academic books or journals. | |

I agree to take part in the above project

| | | |
|---|---|---|
| Name of participant | Date | Signature |
| Name of person taking consent | Date | Signature |

## Appendix 8: Interview Schedule

**Broad questions and general background information:**

1. Tell me the story of how you came to be a student on this course, at this university?
2. Tell me about your life story? Your background, your difficulties, your opportunity and etc?
3. Tell me about your family's background; their level of education and their careers?

**More focused questions:**

**Choice of course/university**

1. Why did you choose this course? What were the key things that influenced your decision?
2. Was there a decisive moment or key event that influenced your decision?
3. Were there any other options that you considered?
4. Was this your first choice of course? If not, what happened?
5. Did anyone encourage you to choose your course? Why?
6. What does your family think of your choice to study in this course? What about your friends?
7. Have you ever consulted with advisor regarding your degree programme? What is your opinion towards advisors?
8. Who supports you financially? Why?

**Experience of the course**

1. Tell me about a typical day at university? What do you normally do at university?
2. Tell me about your class environment; your class mates, your teacher and your position within the class – i.e. who is clever, not so clever etc?
3. Tell me about your course material, lab environment, exam and etc?
4. What do you think about your faculty?
5. What do you think about group study in your faculty? What about the relation between male and female students?
6. What is your definition of laziness and cleverness?
7. Has your experience of the course been as you expected it would be?

**Aspirations**

1. Tell me about your future ambition? Where do you see yourself in 5 years time?

2. Have you considered studying/living abroad? Why?

**Explicit focus on gender (end of interview)**

1. How would you define a successful woman? What kind of life do they have?
2. Does going to university change how you feel about marrying and raising a family?
3. Do you think men higher in their scores in this course? Why?
4. Do you think is there any differences between women who choose maths/ engineering and men who choose maths/engineering?
5. Do you think your course is masculinity?
6. Do you think mathematics is masculinity subject?
7. What is your opinion towards single gender schooling?
8. Are there any differences between female and male lecturers?
9. How do you analyse the position of men in authority? What about the position of women in authority?
10. Do you think in general it is easy for women to participate in labour market? Why?
11. Who is/are your role model? What was their path to success?

**Group discussion**

1. What do you think of national exam?
2. What do you think of compounding high school with conservatory school?
3. What is your opinion towards the black color of society?
4. Do you have any other thoughts/issues that you would like to talk about more?

# Appendix 9: Pilot study

## Pilot study

The aim of this report is to evaluate the use of the theoretical framework (figured world). The data analysed here comes from a series of two interviews with a British Asian Woman (Pari) who had chosen to study mathematics at a British university. These interviews were conducted as part of the TransMathematics Project (by other researchers) and I have analysed the transcripts in order to evaluate narrative analysis as a useful method for my main PhD study. The analysis here focus on how Pari self authors her identity as a mathematics students at university, her identity as a British Asian Muslim women and her future identity as a mathematics teacher within these figured worlds (FW).

## Pari's story

### Summary statement

Pari has chosen to study mathematics at university and at the time of the interview was enrolled at Modern university (pseudonym). She has been interviewed at two data points across her first year at university where she was asked questions about her choice of degree programme at university, her future aspirations and her student life as she progresses through the second year of study. Gaining access into Pari's experience towards studying mathematics at university was a process that spanned from November 2008 (DP4) through to October 2009 (DP5). Her interview at DP4 mainly emphasised her choice of degree programme at university and her experience of studying with boys at university at the beginning of the course. Her interview at DP5 mainly focused on her experience of studying at university and it has shown how her experience at university can challenge the cultural norm of British Asian women.

Pari is a Muslim woman who 'always loved maths' and 'always wanted to do maths.' Her choice to become a mathematics teacher was formed at the later stage in her educational career in response to positive and negative experiences with three different mathematics teachers. Various different resources are drawn on in her story to support her identity as a mathematics student and her identity of becoming a mathematics teacher. Feeling different (isolated) and being a role model are themes consistently repeated throughout her interview data. Nevertheless, this is not a story without troubles and Pari speaks of health

problems, travelling time and financial considerations in this respect. The challenges she describes relate to resisting the cultural model of mathematics (bad view of maths) and perceived cultural barriers of being an Asian Muslim women. As a result, studying mathematics and being a British Asian female are parallel lines in her story which allow her to enter to new world where she can challenge these cultural norms.

At DP4, she has just started her student life at Modern university and she reports that she is 'a bit upset' of this because she couldn't meet the entry requirement for Riverside University. However, by DP5, it is clear that Pari feels more settled and her view towards Modern university is more positive than before. She did well in her assignments and she has made friends with her classmates. She likes the style of teaching, teachers, learning materials, people and environment as a whole. Whilst she makes some negative points about her experience of teaching and learning at university ('independent study') – these comments do not change her positive view towards studying at Modern university.

Below I will provide a narrative account of her story using Holland's framework (with some help from Bruner) to explore how concepts such as Identity, cultural models, figure worlds, self-authoring, world-making and troubles feature in her story. At the end, I will summarise the findings of this narrative analysis and explore the value of this theoretical approach in answering my own research questions on women's choices and experience of studying mathematics and engineering in Iran.

**DP4**

DP4 takes place in November 2008 at Modern university. At this point, Pari has just started her student life with an ambiguous feeling towards Modern university. Riverside University was her first choice but she didn't get in because her grades were not very good and she ended up to study at Modern university. To explain not getting a place at Riverside Pari speaks of her health problems from her final year at college. She says last year 'it wasn't a very good', 'I'd been quite ill over the year' and 'my attendance had been very poor'. Pari is feeling 'a bit upset of that', but at the same time she is feeling ok and looking forward for 'fresh start' for upcoming year.

**Her choice to study mathematics at university**

Pari suggests her preference for Riverside University was influenced by others who she knows have studied there, 'my sister in law came here a good few years ago', 'I have lots of friends who were coming here', and 'my brother went there as well'. Thus, these people are important figures in her story as she wants to be like them and they are guiding her pathway. However, she prioritises her brother's influences over other's influence. This claim reflected upon from dialogue below when she asked to answer this question 'did they influence you in any of your decision?'

> '*My brother did but well, before I made my decision, my brother wasn't married so my sister in law, her influence wasn't there because obviously she wasn't involved in our family, erm but my brother's, he, he obviously he just at that one point, you know when I was ill and I wasn't going to college and he said to me, you know just get through college and you'll be fine at university so*'.

Pari also talks about her future career believing that she would have 'better career prospects' if she had gone to Riverside. This theme emerges from following dialogue:

> '*I wanted to go to Riverside because I just thought erm, sometimes when you go for careers and stuff they have better career prospects*'.

In addition, she speaks of her choice of university in terms of its location stating 'it would have to be at Riverside or the Modern University because of the localities'. We might argue that both of these beliefs draw on cultural models - firstly in relation to high and low status university degree programmes which have different forms of exchange value in the employment market and secondly- a cultural model that is relevant to her identity as a British Asian female where going to university means staying near home. Consequently, she self-authors her choice of university based on the influence of other family members (figures), the importance of location (near her family) and in terms of status of the institution (cultural model).

Pari states that her choice to study mathematics was her own choice which came from her heart. This claim is reflected upon 'I have kind of always had my heart set on doing something in maths.' Pari believes that she had free choice over which subject to study

and states that whilst others influenced her choice of university, no one informed her decision to choose maths. In fact her freedom to choose seems crucial to her story, as she later says ‘I wanted to do something different, I didn’t want to er, everyone was going into psychology and kind’. So standing out from the crowd is important to her - with 'others' influencing what she does NOT choose in terms of degree subject. Thus, her feeling of being different gives her this opportunity to position herself as a mathematics student. The figure of the ‘other’ student (who opts for Psychology) is a figure in her story to which she dis-identifies with.

In self authoring her decision to become a mathematics teacher, Pari draws on her relationships with her previous mathematics teachers. Pari’s first memory here is positive - at the age 14-15 she had a 'brilliant mathematics teacher' at GCSE level who she describes as ‘definitely a role model for her’. The encouragement from this teacher motivated her to do ‘more research on mathematics teaching’ and she noticed that ‘there was a big gap-there, weren’t enough mathematics teacher’. However, as she progressed through college studying A-levels, she found her new teacher not very good and she felt ‘disheartened’ from mathematics but ‘still wanted to do it’. Pari describes her college mathematics teacher in somewhat negative terms:

> *‘She was never prepared, she would, everything was just taught from the book, there was no self explanation, and erm we were left to do our own work which is ok but if we were ever stuck there was no additional support and, it just wasn’t what I expected because all my others in other teachers in other subjects, they gave us the working, I understood it, I didn’t have a problem with that but will with it was just, the teacher would just copy from the book, which I found a bi frustrating at times because the book didn’t always explain, It just had questions there and when she’d make a mistake she wouldn’t know how to explain it, so then we’d get more confused so, it was things like that and she kept, she went off a lot of the time on erm sick leave and she was depressed and kind of’.*

However, Pari got a new mathematics teacher for her second year in college who was an ‘excellent teacher’ because ‘he wouldn’t just go through the book and he would explain in his own way as well’. In this way, we can see the figures of a good teacher and a bad teacher (hero and anti hero) in her story and she uses this to create a new figure of good

teacher. The good teacher from Pari's point of view is a teacher who provides the methods and should be always there to support:

> *'As long as I know which method to follow then of course I can find it myself. That's not a problem, but if I ever get stuck erm, you know I need to kind of have that support from the teacher sometimes when you need to go and see them'.*

Therefore, she is self authoring her future identity as a different kind of teacher in relation to these figures and states that her model of teaching is not same as her previous teachers and she has her own method of teaching. Nevertheless it is clear that these figures are key to informing her notion of what becoming a good teacher is - they resource her 'becoming':

> *'I've picked up along the way some different teaching methods from my teachers, what's been successful and what hasn't so'.*

Another resource in Pari's story seems to be a cultural model that mathematics gets a 'bad impression'. She believes the 'bad impression of maths' many people have is mainly rooted in bad teaching of mathematics'a lot of people don't enjoy mathematics and I think it is probably because they have not had a good experience of it, with whoever's teaching them'. She repeats this cultural model throughout the interview data saying; 'people are afraid of maths', 'people have bad impression of maths' and 'a lot of people don't enjoy maths'. As a result, the 'bad impression of maths' becomes a cultural model which resources her choice to become a mathematics teacher in order to change people's view of maths. This is evident in the following:

> *'Money business or this career, it didn't really interest me that much, I think teaching I kind of, you are more working with someone and you can take something on later on in life, it maybe, you could change someone's perspective on maths'.*

As can be seen above, she also aligns herself with a cultural model of teaching for social good (with spreading a more positive image of mathematics as part of this) and positions this cultural model against values which desire money and high status careers. Thus, her storying of herself as a mathematicsstudent and her becoming a mathematics teacher is resourced by her need to

challenge the cultural stereotype of mathematics and a belief in teaching as a means to do this. Her identity of a 'becoming' mathematics teacher involves entering in to a new imaginary world where she can see her selves challenging these norms.

**The experience of Studying Mathematics at university**

Pari speaks about her experience of studying at university in terms of gender which is seen as problematic in terms of getting along with her peer group. She says that ‘my class is a bit weird because it’s mainly boys’. She sees this as a problem because of her previous experience of studying in a single-sex school for some period of time. Consequently, she tries to leave this ‘weird feeling’ behind by creating a new cultural model that ‘boys are more mature in university’ and ‘they will be easier to handle’. Therefore, her need to become a good student on her mathematicsdegree appears to lead her to change her belief about boys at university and this then gives her an opportunity to take further action which is to make new friends:

> *‘So, but I’m sure I’ll get used to it, I mean I’m, when it comes to people I’m not the shy type, but I’m not like very loud that I’ll be disruptive and stuff but I can make friends and I’m, I don’t think it will bother me because I know, people when they come an do degrees they’re not immature whereas in college I think boys are a bit immature so. Hopefully they will be a bit more mature here and they will be easier to handle’.*

**DP5**

DP5 takes place in October 2009, about one year after the first interview. After one year at university Pari is feeling more ‘confident’ as ‘at the beginning of the year she was very shy’. She has started getting to know people and asking questions in lectures stating it ‘took me time to make friends to actually ask the lecturers and the tutors’. By this time, her image of Modern university is more positive than in DP4. She likes the exam support because ‘when the exam came we had a lot of revision support’. She did well in assessment; she got 94% in her computerized assessment in mathematics because mathematics and IT are her favourite subjects. She finds the method of teaching very

practical, as they mix both explanation and practical exercises together ‘they would explain it and then we would do it, so it was really good’.

After one year in university she now feels more included into student life, she had made friends and she feels part of a group now. Her career desire towards teaching is getting stronger ‘I actually taught to year 11 and year 9 then, I really, really, I just loved it. I really loved it, so I though, yeah, definitely, definitely the career path for me.’ And she wants to finish university in order to be a mathematicsteacher sooner ‘I just want to finish my degree so I can go into teaching. Just finish it, finish it’. Once again the cultural model of teaching as doing a social good is re-iterated and this is linked to a belief in helping people as being rewarding:

> *‘There’s a definitely a reward in terms of somebody has learnt something, you know, forget, if not thirty people, if one person has learnt something, the satisfaction of that…’*

Besides these positives points, there are however some negative points or troubles in her story at DP5. She finds the mathematicscourse (which does not contain a lot of pure maths) as not matching her expectation. As well as that, she is not quite satisfied with the pedagogic model of ‘independent study’ at university which she feels does not resource her identity of a good student. She expresses her feeling below:

> *‘I make sure everything is done, but at university it’s all up to you, so I think given the fact that you are just, sometimes it feels as though you are just a number.’*

From dialogue above, the term ‘we are just a number’ shows a perception of a cultural model relating to university systems and structures – students are just numbers in the system, who bring in fees/money. This is not satisfactory for Pari who wants a relationship with her lecturers so she misaligns with this cultural model. If we consider her alignment with the figure of a good teacher outlined in DP4 we might suppose that she believes 'independent learning' is antithetical to this and therefore, is not part of her story of becoming.

Another 'trouble' evident in her interview at DP5 are her health problems which are an ‘ongoing problem’ - ‘still got it’. This has caused problems for her throughout her studies at university:

*But, erm, on the first week, I came in on the Monday and then got admitted at A & E that night……so I was off the whole week. Erm, and in terms of that it's just, I've just finished catching up now.*

The other difficulty which she mentions here is the long distance she has to travel from home to Modern university. She finds this journey 'horrendous' as it involves wasting time and wasting money. Money is another problem for her 'I only work two or three hours a week, so, I, you know, I don't didn't have a lot of income'.

As Pari progresses through the second year of study, she finds the course is getting 'harder' because she has to remember all the formulas. She questions the memorisation of these formulas stating that although they are useful for progression with her studies they may not be so useful beyond her course 'in terms of afterwards I don't know'. At DP4 she drew on a culutral model that mathematics is 'involved in everyday life activities' and therefore has a 'use' beyond her course. In contrast, at DP5 she doesn't think any of the mathematics in her degree will benefit her in future career:

*'Actually if I am honest I don't think any of my degree will be useful, because I want to focus specifically on GCSE, year 7 to year 11. So, a lot of the things I have done it just for me. I don't think it will benefit me in the career...'*

For her second year of study, she plans to change her current behaviour in terms of poor attendance and laziness. During her first year, her decision to go to lectures depended on whether she understood the content or not 'if I didn't understand I'd definitely come in, but, you know, when I did understand, I thought, oh, I understand it, okay, that's easy'. And sometimes she would say to herself 'it doesn't matter if I miss today, I will catch up on the work'. However, her story at DP5 expresses regret that she didn't attend more during Year 1 and she didn't do extra studies 'Now, I'm going to go in even if I understand it, I'm going to go in and do the work', 'so from last year the only regret was being, being a bit lazy'. Here she self-authors her past self as a 'bad student' - a figure in the story and she uses this personal reflection as a tool to create a new identity of a successful student. Thus, successful student is 'someone who comes in all the time', 'asking for help when you need it' and 'doing self-study'.

In terms of cultural barriers, Pari talks about being a British Asian female who lives in a satellite town on the outskirts of a major city. She is aware that she is moving away from the typical trajectory of her peer group and self-authors a different identity as a British Asian female who is challenging the traditional Asian cultural model which has denied girls the opportunity to go university:

> *'it's very different between me and my friends, because we are kind of the generation that was born here, brought up here, were schooled here, but even then there is still some barriers in terms of, like, culture or in terms of area, like, Rochdale and Oldham who don't send a lot of people into higher education, or even education full stop. Erm, and, and just really to tackle that, because I've got friends who are very smart. And after A Levels their families are, like, no you're not allowed to study'.*

She also talks about her Mum's skepticism about the value of going to:

> *'My mum didn't say you can't go, she just, she doesn't, my mum didn't see the point of studying, because she's never done it…and she's never worked, she's always been a housewife'.*

Furthermore, Pari believes that one of the reasons that some families do not allow their daughters to go to university is because they 'become bad' or 'become independent' and she says 'there is still that in my family'. But from Pari's point of view 'becoming independent ...it doesn't mean you are becoming bad' and this is a clear response to parents who are not give permission to their daughter to go to university.

As a result, Pari is resisting the trajectory of her family cultural model, the identity as a British Muslim women and the doubts it raises about university and this becomes a tool for her to overcome cultural barriers and to position herself as a role model to tell everyone that 'look I'm doing it. I'm a woman, I'm Muslim, I'm, you know, anything that you think, oh, we can't do it, because I'm that, I'm doing it and there's no harm in it'.

Here, we can argue that Pari sees herself as 'worldmaking' - in becoming a mathematics teacher she intends to offer herself as a 'figure' to other girls in order to challenge the

cultural expectations of Muslim women and as such transform the figured world women like her occupy. Her message here is also about transforming girls access and participation in mathematics and she makes a strong argument that there is no distinction between men and women:

> *'I mean on my course there are men and women and boys and girls we're equal, there's not, you know, more than…I think, you know, there's no, they never say oh, well you don't understand that, because you're a girl or, you know.'*

As a result she draws on her personal experience as a role model to everyone to give them this message that:

> *'University is not the kind of place that they think it is. It is not so scary, it is not so alien in a sense, you know, it's okay to go to university'.*

**Summary of the narrative**

My analysis of Pari's story has generated some themes which directly relate to the concepts of figured worlds, cultural model, figures, world-making and troubles. I have summarised these themes below:

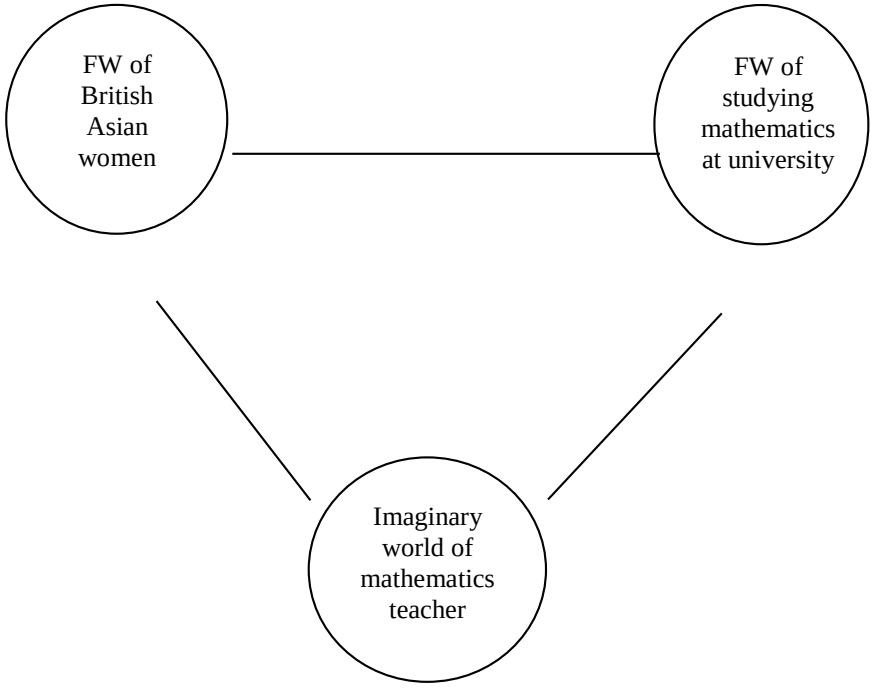
**Figured Worlds**

Figured worlds in this study are: i) the FW of studying mathematics at university; ii) the imagined FW of mathematics teaching; and iii) the family/community FW of being a British Asian Female. These FWs relate to each other since becoming a mathematics teacher seems to be about imagining a new figured world which bridges the other two FW. The FW of British Asian women includes issues such as women should not go to university, women can't study mathematics and her different feeling from 'others' (her friend peer group). The figure world of studying mathematics at university includes issue such as people are scare from maths, bad view of mathematics coming from bad teaching of maths, her positive experience towards studying mathematics at university and her different feeling from 'others' (who opt for psychology). Feeling different, being role model and challenging cultural norms are themes that emerged from these two FWs which

are relating to each other, combine together, become a tool and lead her to imagine herself as a mathematics teacher in future.

This process demonstrated below:

Figure 4: The correlation between FW.




**Cultural Models**

As stressed before, cultural models are identified here as socially shared symbolic terms, beliefs and values as it rooted in society and family background which in this case, are drawn on and used in self authoring. These cultural models are part of the FWs of studying at university, the imagined world of mathematics teaching and the family/community world of being a British Asian Female:

Cultural models relating to the FW of studying mathematics at university are:

- Cultural model of prestigious universities: the belief that certain universities are better than others.

- Cultural model of university degree: The belief that university degrees should give knowledge which is useful beyond study (i.e. career).

- Cultural model of boys behaviour at university: the perception (by many girls) that boys are generally immature but at university they are more mature and therefore they will be easier to get along with (or perhaps more 'desirable').

- Cultural model of university structures: students believe that they are just numbers in the system who bring in fees/money.

- Cultural model of university pedagogy: teaching-learning at university is about independent study compared to other forms of pedagogy such as small group work.

- FW of British Asian family/peer group:

- For British Asian Muslims - women go to local universities which enable them to stay near home.

- Cultural model of family/community: British Asians who live in Rochdale send very few people (specifically girls) to university.

- Cultural model of family/community: some Asian families believe that if they send their daughter to university they will become too independent.

- Cultural models in the imagined FW of teaching maths:

- Cultural model of teaching: teaching careers are seen as doing a social good in terms of helping people and therefore, teaching is not about earning a lot of money.

- Cultural model of mathematics teacher: Society's negative view of mathematics is rooted in bad teaching of maths.

- Cultural model of maths: people don't enjoy mathematics in general and are afraid of it because it has a poor image.

**Figures**

As mentioned above people in FWs usually play particular parts or roles as figures; e.g. the heroes and the villains (anti-hero). For this study these figures are:

a) In the FW of studying mathematics at university Pari talks about the figures of her family members and friends a who are guiding her pathway as she wants to be like them: 'my sister in law came here a good few years ago', 'I have lots of friends who were coming here', and 'my brother went there as well'. She mentions these

people's names as figures who have attended River Side University but she thinks her brother is the main person who influences her decision.

b) In Pari's story the imagined FW of mathematics teaching is the one where the bad teacher acts as an anti-hero because she 'was never prepared', she 'taught everything from the book', 'she left students to do their own work' and 'she never provides additional support'. But the two other mathematics teachers she discusses act as heros because they provide additional support and they encourage her to do more research on mathematics teaching.

c) In the FW of studying mathematics at university, she speaks of her past self as a figure of bad student and then she uses this personal reflection as a tool to create a figure of a successful student- a new identity for her. Thus, the successful student is 'someone who comes in all the time', 'asking for help when you need it' and 'doing self-study as well'.

d) In the FW of studying mathematics at university, she talks about the figure of 'others' who she doesn't want to follow their foot step and the figure of herself as someone who is different from others. Thus feeling different becomes a tool and motivates her to choose mathematics as a subject.

**World-making**

In terms of world-making, Holland et al. (1998) talk about the Tiij festival where the women of Nepal could come together and sing songs about their oppression at the hands of men. Gradually through engaging in world-making they begin to work together to find strategies for overcoming such oppression. So the Tijj festival figured world changed and became a more political space rather than simply an opportunity for the women to socialise. Therefore, we can say that world-making is evident where people see themselves in a new imaginary world where they can transform the existing social structures of what is currently experienced. In this story, Pari's FW are also transformed and shaped in to new forms which are described below:

The figured world of her community peer group (British Asian women) and the figured world of studying mathematics at university are to be transformed through her imaginary becoming a mathematics teacher. Enacting this trajectory (i.e. going to university) involves offering herself as a 'figure' for other girls so that cultural expectations and restrictions are challenged. Also within this imaginary FW of teaching maths, Pari believes she will transform and challenge the cultural model of mathematics to create and offer a new figured world where mathematics is seen more positively. Therefore, the

figured world of teaching mathematics is to be transformed through her imagination of becoming a different kind of mathematics teacher who can change some norms in society.

**Troubles/Conflict in story:**

Troubles are difficulties Pari faces during her life path as a mathematics learner. In this respect Pari speaks of health problems, travelling time and financial consideration. In terms of university, she is not quite satisfied with the pedagogic model of 'independent study' which she feels does not resource her identity of good student (her model of teaching and learning is to have a relationship with lecturers). She also finds the mathematics course is getting harder as she progresses through the second year of study as it involves lots of formulas. At DP5, she questions the memorisation of these formulas stating that although they are useful for progression with her studies they may not be so useful beyond her course. Thus, she starts losing faith in the belief that 'mathematics is involved in everyday life activities' as she progresses.

## <u>Appendix 10:</u> Interview with Zahra

**Interviewer: Nooshin**

**Interviewee: Zahra**

N: I have looked at your questionnaire and there were some issues in there which I would like to ask from you. But some of these issues were actually in the interview questions, now do you want me to start from the questionnaire or the interview questions?

Z: It doesn't matter, whatever you think is better.

N: Well, let's start from the interview questions?

Z: Okay.

N: Tell me about your past? How did you come to be a student on this course, at this university?

Z: You mean I should start from the beginning to tell you about when I became interested in maths?

N: Yeah.

Z: When I was in grade 5, I was ahead of my classmates in doing mathematical equations; that time we lived in suburban (X city) and not lived in Y city.

N: Do you mean that in grade 5 you understood that you were ahead from others in maths?

Z: Yeah, I always solved mathematical equations but others did not or I was quicker than others and got the point quicker. Then, the teachers encouraged me to study more mathematics and their encouragement cause that I liked mathematics more than any other subjects. Since, I understood mathematics I tried to study hard in order not to stay behind and this was the reason that pushing me forward in maths. Then, I went to the junior school, at that time I hadn't decided yet to study mathematics for future. But my mathematics was still good. I was always ahead of my books and classes and studied before the lesson being taught and the teachers always told me that you are better than others in terms of mathematical ability.

N: You mean that your teachers at junior school understood this issue as well? Right?

Z: Yeah, exactly, all of them had noticed this issue. I remember, when I was at second year in junior school, I asked the teacher a question and she gave me an answer and I told her I know another way to solve this, she said what is it? When I told her the answer she surprised and asked me where I got this answer from. I told her I found it by myself and she told me that we can record this in to your name. But later we found out that there was this way before.

N: Really, the solution came in to your mind suddenly, when you were in the class?

Z: Yeah, I used to find other ways for doing mathematics equations, so I was encouraged by teachers. As an example in the mathematics test competitions that we had in our schools, I always got the highest score. So I liked taking a part in mathematics competitions and I became first in our town as well. That time I liked maths, but not that much to choose mathematics for future. I remember when I was at third year in junior school; the mathematics teacher Mr X told me that you definitely study aerospace engineering as this major was new at that time in Iran with having a good position. I said I don't know what I am going to study but I might follow maths. For the first time, I said that I would like to choose maths. He told me engineering has lots of mathematics in it and I told him I am not sure yet, I don't know anything about aerospace. Then, I moved to high school. When I was at first year in high school, Mrs X was our mathematics teacher; she was PhD student from other city and taught in our school. First time she came to our class, she didn't teach us and she only asked about some of the main concepts in mathematics and it was only me who answered. She asked me about my background in mathematics and I told her that I have been working a lot in mathematics and I like maths. After some times, she noticed that l like mathematics very much and she really encouraged me on that. Even it got to the point that she told me to held class for students and taught in the class instead of her. Therefore, my passion towards mathematics was getting stronger. She helped me to do more research on mathematics and I went beyond the school books. I was a bit lazy but I really liked maths. Then, at the first year of high school I made my ultimate decision towards studying maths.

N: You mean to study mathematics at university?

Z: Yeah, at the beginning of high school I was sure that I wanted to study pure mathematics at university and I was very sensitive on doing pure maths, I liked it to be purely maths.

N: Why?

Z: Because I wanted to study only maths.

N: Oh, you only like maths?

Z: Yeah, I forget one thing to say. When I was at third year in junior school, I proved that Pythagoras theory, such an important theory with all of its 380 evidences, was wrong. When I showed this to the teacher, she told me this is impossible and I asked her to show my mistake. She could not find the error in spite of lots of efforts. I think I showed it to somebody else but she/he could not find the error. Later, exactly after finishing junior school in summer time, I found out my own mistake.

N: Ahan, you found your mistake?

Z: Yeah, after this incident I became familiar with the name of mathematicians and I started to read their biographies. Other students also called me Pythagoras, making me sure that mathematics is my ultimate choice. When I was at first year in high school, my older sister got married and her husband was a PhD mathematics student at that time. He told me that the subject of pure mathematics is going to be removing soon, so there won't be any pure maths. I said what do you mean by that? He said pure mathematics will be combining with applied mathematics and some of the four module lessons will reduce to three module and some other lessons will be removing totally. I remembered when he told me this issue; I cried a lot and said I can't study pure mathematics anymore. I tried to understand what the change was exactly, and when I was in second or third year in high school I could understand that there isn’t any pure mathematics and those who enter to university in year 2013 will study the new subject named mathematics and appliance.

N: Oh, this issue was finalised? Pure mathematics was removed totally?

Z: Yeah, but we do have the branch of pure maths, e.g. we choose mathematics and appliance and we can change it to pure mathematics later on. For example, one can go to

management and one go to pure maths, but it is not as pure as it used to be. Then, the good teacher from first year at high school left the school, despite being influential, my passion to mathematics remained unchanged after her leaving and my interest towards mathematics was increasing year after year. All of mathematics teachers noticed this issue. But my parents disagreed with my decision to study mathematics and for second year in high school they told me to pursue empirical science rather than maths. I told them I don't like science and they accepted that I study mathematics in high school. As far as I can remember my family has been always disagreed with my decision to study maths. They suggested me to choose empirical science to be a doctor, just for having social prestige. Ultimately, they agreed with me to study mathematics at high school.

N: Why? Do you know what the reason behind their disagreement was?

Z: Future job. My brother and my sister both studied engineering, and nor my parents nor my sister and brother satisfied with it. They wanted me to be a doctor, because of the name, maybe this could be the reason.

N: You mean that they disagreed with your sister and brother to study engineering; they wanted them to be a doctor?

Z: Yeah. After that, I went to study mathematics for high school. When I took national exam I chose mathematics subject as well. My score was 3000 in second region.

N: Oh, because you live in suburban you count as second?

Z: Yeah, well, big cities like Y city and Z city count as first, and my area comes as second. I didn't study for national exam. When I was at Pre-University I was only studying maths. I didn't even do that much test for the exam. That time I studied something which I study now in mathematics at the university. All the time I was reading the story of mathematicians. I remember I was painting and the only thing I could paint was the picture of mathematician. I couldn't draw anything else. I can recall that all the time I was interested in activities like this. Once in the Week of Research I was in charge of the executive section in mathematical cultural exhibition while I was in pre-university level. So because of the extra activities, I did not succeed in obtaining a good ranking in the national exam to be accepted in the best university (Hafez University). That time I was telling myself that if I wanted to study mathematics I would study at a good university. I

knew that mathematics doesn't need good grade to compare with engineering, thus I didn't study that much and I knew I would be accepted in mathematics anyway. On the day of major-selection, my family didn't allow me to choose maths. My sister suggested me to choose mathematics at Hafez University as the first and engineering majors at Z city University after. I said no, I am not going to do that. My sister was the main person who disagreed with it. She tried to convince my parents to not let me to go to maths. The only person, who wanted me to study maths, was my brother in law, who studied mathematics as well. He knew how much I like mathematics and he was aware of my mathematical ability. My sister knew that I listen to her husband, so she asked him to encourage me to choose engineering. But he didn't, and I remember there was even an argument between them. She lied to me, she told me that her husband want me to study planning engineering. I said ok, I will choose engineering. But I didn't, I lied to her. First I chose mathematics at Hafez University, then Y city University, A University, Jesus University, B University, then C University, D, Z city, E, F and G. In total, I chose 11 universities.

N: All in maths?

Z: Yeah, all mathematics and appliances. This was a grief that I couldn't study pure maths. I remember on the day of selecting course for university, we had time till 10 pm to change our subjects. On that day I was extremely hesitant about what I had selected, quite vividly I could remember that everything around me were tempting me to alter my decisions. As an example, it was a program on T.V which called 'to God' and Mr X was explaining that what you decide on must be in accordance with the society's need not with your desire and interest. I remember this clearly; when I noticed he is saying the same things as others made me angrier. Till 10 I had one hour to change, I decided to get divination from Hafez, to give me strength. But the meaning of the poem was that the way you have chosen is wrong and you should change it till not get too late (laugh). It was a really bad feeling.

N: Are you serious (laugh)? Well, what happened that you didn't change? Was it your love to maths?

Z: Well, I didn't choose any other subjects. I hoped to be accepted at Hafez University and the chance of acceptance was 70% that time. I checked last year grades and the person who got a similar grade to me were accepted at Hafez University. I was thinking even if I do not accept Hafez University I would definitely accept to study at Y city or A University. It was really strange that year, the grades were changed. Maybe the number of students increased. Once, seen the result, I cried a lot.

N: You prefer to study at Hafez University?

Z: yeah, I remember the first person who became aware of my result was my mum. She told me my dear daughter if you want to be accepted at Hafez University, you must study one year more. Then my sister said to me that you accept in mathematics at Jesus university , this major is of no use. Finally my brother told me that you couldn't make it to go to Hafez University. Everyone in the family was telling bad stuff about me, which was really bad. Then, I came to the university. I was very happy at the beginning as I was studying maths. But, I was sad as I couldn't go to my favourite university. For the first term we didn't have any specialised courses in mathematics and it was only one course which was called general mathematics one. At the second term I noticed that this university is good and there is no difference among universities. I met some of the great lecturers here, like Mr X. I don't know have you ever met him or not? He used to teach in here but last august, he left Iran. He was really good, and I noticed I am here as I suppose to be here. I confronted with many helps in here and if I went somewhere else, these things wouldn't happen to me. I am very happy of my course but not from the university. Well, I think I have answered the question 1.

N: Yeah, I think you have answered question 2 as well?

Z: Yeah.

N: And question 3 as well. You talked about your family too? You wrote here about their education and their occupation, right?

Z: Yeah, I wrote.

N: Now, what does your family and friends think about your course?

Z: My friends, those who have been with me since the first year of high school, are positive about me and my studies as they have all known that I would end up studying maths. They called my name to the name of mathematicians. But my family and my relatives think because I wanted to be at good university I chose maths. They think that if I wanted to study engineering I wouldn't study at this university and would perhaps study at Z city University. So, they think because of this university I chose maths.

N: Now, many of your friends think that because of being at a good university you chose maths?

Z: Not my friends, my family.

N: Ahan, family.

Z: My friends were sure that mathematics is the only subject I like. My family known that I liked mathematics very much and they still know about it. Now, my mum and others notice that I enjoy maths, but still they have no faith on my future in maths.

N: Because you may not find a job in Iran? How come they have faith in engineering?

Z: They don't have faith in engineering, but they told me I could find a better job in engineering.

N: Who support you financially? Why?

Z: My father. Because I am her daughter, he likes me and doesn't want me to suffer.

N: Even though he wasn't satisfied with you to study maths, he still supports you?

Z: This couldn't be the reason, he is my father.

N: Ahan, true. Well, how do you describe a typical day at the university? E.g, what do you normally do at the university?

Z: It depends on the day. As an example there are some days that I have classes with the good lecturers and I love the lesson. Extremely enthusiastically I get up early every day even without any alarm clock. On the way I study Maths, indeed I live with it. I attend the classes, remark and challenge on the mathematical issues. Even some time I become so nerve racking that others cannot stand me. I don't know what the reason behind this is? But it may result from their jealousy. Sometimes my classmates make me angry and even some of the lecturers.

N: In what way, for example?

Z: For example, they told me you answer all the questions and the lecturer thinks we all know the lesson. So my classmates think because of me lecturers do not re-explain the materials when they supposed to do so, and my classmates tell me do not show your understanding to the lecturers. For example, I remember last term I participated in a class named Mathematics Analysis which was ahead of my level. I was so good at that course that I could answer many of the questions. This capability of mine was so annoying to the classmates that they sent posts on the Facebook to prevent me from any comments 'those who do not belong to this class stop remarking'.

N: Well, did you give any comment; I mean did you defend yourself?

Z: No, I talked with the lecturer, he wanted to persuade the students, but I requested him not to do that. I said that this was their class so their right to take advantage of this class. They may be upset that I am talking, but I wasn't talking in the class, when the lecturer asked I replied. Then, now, even in this term which is my own class, students and my friends are saying the same things.

N: Do you think this kind of behaviours has changed your attitude?

Z: Yeah, very much. I have become quieter. From that time on, I have become less interested in talking and remarking in the classes. Although my internal enthusiasm is still there, my interest in talking in classes is getting less. I sit in class and I am watching without talking. When the lesson starts I get enthusiastic and it's difficult for me not to talk when I notice I know the lesson. I get excited and my heart is beating fast and if I don't express my idea I get a bad feeling.

N: Well, now, you talk less in class?

Z: Yeah, very much. Then, even some of the lecturers are doing same kind of behaviours. It is not like that they get happy when one of the students makes comments. There are good ones too, but very few. For example they don't have free discussion in the classes. We normally are writing notes in class and they give us a booklet to prepare for exam. Interestingly students prefer this procedure. Most of the students get the good mark from this system; they don't like mathematics and they don't even know how to solve mathematics equations.

N: Do you think these things are affecting your feeling towards maths?

Z: No, never. Nothing can change my feeling.

N: That's good (laugh). Well, about classes, do you think your classes are comparable with International standards or not?

Z: No, never. 90% of classes are not. Lecturers just rely on a fixed booklet or a book and they don't go any further. If you just ask any further question they say that it belongs to other lesson and you will get the answer later. But I know two lecturers who are not like

that. Then, the other thing is about the way they are assessing students. In one of our terms on the final exam I got 20[20] on the paper but the teacher added 3 points to all the scores. So, those who got 17 they got 20. I could get 23 and the interesting part was that the exam was from booklet.

N: Do we have 23 (laugh)?

Z: We had extra mark, I got 20 and those who got 17 they got 20 as well. Last term I could get 20 in one of the exam but because I did not submit any homework the lecturer gave me 16. I'm saying that they should at least be like each other, although none of them are good.

N: The lesson booklet or book, are they providing or you have to buy it by yourself?

Z: No, they say it in the class or write it on the blackboard and students take notes.

N: Do you have computer in classes?

Z: We have some; very few, some classes have it.

N: Do you have the computer system of lessons?

Z: No, we don't. Sometimes lecturers make slides and they show it in the class. It's more for the lessons with graph on.

N: Well, many lectures give you a booklet and you read it? Right?

Z: Yeah, they introduce books as well, but students at home study booklet most of the time.

N: How are the books?

Z: The books are good.

N: About the writer of books, are they Iranian?

[20]The exam score in Iran ranges between 1 and 20.

Z: No, most of the books are not written by Iranian. So we either read the origin form or the translation form.

N: By the way, do you have lab?

Z: No.

N: You don’t have lab at all?

Z: We had just a two-module lab course, which was called maple mathematical software. We passed two-module and that's all we had.

N: How are your exams? What type of exam are you doing? Is it like you go to the exam on a specific day?

Z: Yeah, before selecting the course, they put the exam date and the time for the exam.

N: Are you not doing any assignments?

Z: No, we don’t. Computer science students have, we always have practice solving class.

N: So, you always do exam? It's like you study and do the exam on a specific day?

Z: As well as final exam, we also do mid-term exams and we do some quizzes in the middle of term. Sometimes we do some projects, but it's mainly specific to solving two simple practices. We don't do hard projects.

N: Do you think men higher in their scores in maths? Why?

Z: No.

N: Why?

Z: Boys don’t get better scores, I can see it. When I separate myself from others, I do not count myself, and compare boys and girls together, there are some boys who have a better understanding of maths. In the atmosphere I am in, I cannot say in total as I do not have a

statistic, I can say that girls are higher in their scores, because they put more effort in and study more.

N: Well, it's like that, boys are better in the understanding of maths, but they don't put too much effort in lessons and exams?

Z: Yeah.

N: But, in general, girls are having better scores?

Z: Yeah.

N: You answered this question in the questionnaire; ' Has your experience of the course been as you expected it would be?' and you wrote here that you are not satisfied with lecturers and environment as whole. But these things didn't affect your good feeling towards maths? Right?

Z: Yeah.

N: Tell me about your future ambition? You wrote one in here, but this a long term future plan, what about your short term future plan? Where do you see yourself in five years' time?

Z: The things that I like.

N: Yeah.

Z: I like to work on a very good project in maths. Not in higher level as I do not have enough knowledge yet. But work on a good project at my level.

N: Why do you think that you do not have enough knowledge?

Z: Well, I have not studied everything yet. Mathematics is a subject which grows fast. For example, if I am working on a project now, somebody else is thinking about it somewhere else. I have not reached to that level yet. Those who are working on big projects, they have at least PhD qualification, and they know what they are doing. Well, I do not have enough

knowledge. Maybe when I read something I can understand it well and can work with it, but I don't know, I don't know everything to work on it.

N: For example in five years' time you would like to work on a mathematics project?

Z: I would like to take a part in mathematics competitions, and for example to achieve some medals, nationally and internationally. One other things is erm, erm, erm, this. There are the things that I would like to achieve. But, if I want to talk about maths, I would like to finish that book, or read that article and think about that subject.

N: Ahan, you wrote something here about mathematicians, that you want to show the mathematician's biography to the mathematics lovers, how are you going to do this?

Z: For example, when I read the biography of mathematicians I deeply go in to their roles. And I know if somebody else read it, they easily dismiss it. Therefore, if I want to explain the story to someone else, I can explain it in a way that the reader goes beyond the reading to understand it very well. Because I can understand how much that mathematicians loved mathematics when their read mathematics and how diligent there were in working on it.

N: Well, do you like living or studying abroad?

Z: Living not. Because I don't like living alone. I want to live beside my family and my relatives. It is difficult to live somewhere else lonely. But for studying I haven't decided yet. If one day I come to this decision that I want something special in mathematics which is not achievable in here I will go to achieve it and come back here again. But I haven't come to this decision yet.

N: How do you define a successful woman? What kind of life do they have?

Z: The gender questions, I don't know the answer to them. In my opinion there is no difference between men and women in terms of success. Do you know what I am talking about? For example, a successful woman or a successful person is someone who is satisfied with her/himself and her/his career. Do the right thing and later don't say that why I have done that.

N: Meaning that don't get regret?

Z: Yeah, don’t regret. As a matter of fact, a successful person is the one who is happy with his life, has an aim in his life, and has a job and excitement. I see success like this.

N: Do you mean you don’t see any differences between men and women?

Z: Yeah.

N: What about the second question? Do you think university has changed your opinion towards marriage?

Z: Before I went to the university, I said I don’t want to get married or I want to get married very late. Marriage prevents me from studying hard and spending time on maths. It is obvious that marriage is time taken. I have this opinion now as well. I have to follow mathematics and this is my priority.

N: You mean first mathematics and then marriage?

Z: Yeah, my priority is maths.

N: Do you think is easy for women to find a job in Iran?

Z: I don’t know that much about job. I don’t have any information about the labour market, for example in my subject there is no difference for women in Iran and foreign countries in terms of finding a job. But, there are some jobs which restrict women’s working in both Iran and outside Iran. In Iran there are some limitations for women as it is not for men.

N: Like what, for example?

Z: I do not know exactly, but it must have some jobs which restrict women's working.

N: Do you know anyone who like to enter to university, but couldn't make it?

Z: No. Anyone who is interested in one particular subject and like university has made enough effort to enter to university, maybe not a good university but at least they could

make it. I see many people who haven't liked university but they come. But, I haven't seen anyone who has liked university but don't come.

N: Eh, you mean you have seen the opposite?

Z: Yeah.

N: Do you know why the opposite occur?

Z: Because everyone feels that they have to enter to university. Studying at university and going abroad have become epidemic in here.

N: You mean it have become a norm?

Z: Yeah, exactly, going abroad is a norm; unfortunately people think that there is no other option except academic studies at academies. While, there are, of course, some other ways apart from studying and universities and going abroad. They cannot imagine a successful life without studying and university. Well, you have high school qualification and you have enough knowledge, why do you want to enter to university? Go to some other profession, you don't need university. I have seen lots of people like that. Because everybody goes to university, so they think they should go to university too. For example, they get their undergrad degree and because everyone studies masters, they want to take master exam and even go to study PhD.

N: Even without having any interest?

Z: Yeah, with no interest.

N: Who is/are your role model? E.g. do you know any specific person who is your role model?

Z: There are many, is it okay?

N: No problem.

Z: Do you mean those who are now or those who belong to past?

N: Say it generally? E.g. who are the most famous one?

Z: From the past, among mathematicians, one is Cantor and another one is Grothendieck. I have chosen them not because of the social statues they had, because I want to reach to their level of understanding.

N: Why did you choose these two?

Z: Because the things they provided in mathematics is relevant to my interest. The way they thought is similar to mine. When I read their biographies I really enjoy it and I want to think like them.

N: Well, you mostly follow the biography of mathematicians, right?

Z: Yeah, true. I like their stories and I like to reach to their level of thinking. I have also a woman role model, Mrs Maryam Merza Khani who achieved Fields medal in maths. She is the greatest woman in mathematics in the world. Then, erm, these role models, erm, was, erm.

N: Do you know what the path of success for Mrs Maryam Merza khani was?

Z: Her interest, effort and a bit of talent. It needs talent obviously but not that much. I have interest and talent but less effort, but I cannot judge myself. I should ask lecturers and those who know me. I am thinking that despite having talent and interest, I am not a hard worker. This is my big problem; I do not have enough effort. Then these role models are getting smaller gradually, erm, e.g., one of my lecturers who have a good knowledge of math is my role model as well.

N: Is it she or he?

Z: It's he who is my role model.

N: Why he is your role model?

Z: I say, I love his way of thinking. Among the lecturers I know, he is the most enthusiasm one.

N: His love of mathematics is greater than others?

Z: Yeah.

N: Do you have any other things to say?

Z: No. I think I have said every things, but if you have any things in your mind ask me.

N: Yeah, you wrote something in the questionnaire and I have some questions about it.

Z: Okay.

N: Now, I will go and start writing up your story and if I have more questions, I will contact you in order to ask you more questions? Is that okay?

Z: Okay no problem.

N: Ahan, in the questionnaire you have separated love from fame in the fields of maths, right?

Z: Yeah.

N: Do you know why you did that?

Z: I see people who are very successful in mathematics but didn't come to mathematics only because they love maths. They like to be a mathematician; do you know what do I mean? I don't like that.

N: Do you like to be someone who like mathematics but don't want to be known?

Z: No, I don't want to be unknown. I like fame as well, but because of the mathematicsI like fame. However, people are normally opposite of this, they say that they like mathematics but because of the fame they like maths. They have talent as well, they are

progressing, but they don't love maths. There are many mathematicians who do not love mathematics but just for being famous they followed maths.

N: So, there are any mathematicians who prioritise fame over maths?

Z: However, this is my understanding. I might be wrong I am not in the position to judge people. I am saying that if there is any mathematician who read mathematics alone and study mathematics only because of the maths, then I can say that he is really in love with maths.

N: Don't you think in today's world fame is higher than science?

Z: Yeah, this exists in the world. This is not specific to great peoples, e.g. in here there are peoples not enjoying mathematics at all, but they studying at foreign universities, get the PhD qualification and they even becoming faculty members without any interest in maths.

N: Do you have group study work in your faculty?

Z: No.

N: You don't do any team work or project?

Z: No, at the moment not.

N: All works are doing individually?

Z: There is a mathematics community which I am one of the active members of it and the activity we do is like e.g. we hold mathematics competitions and in mathematics week we play mathematics activity. It's limited to this, something official.

N: Do you like to work in a group at all?

Z: I like group working, if people in the group like maths. But at the moment I do not prefer to do things in group provided that I have no identical people around me interested in teamwork. Unfortunately I see no such people around myself.

N: So, you think group working is not beneficial?

Z: I prefer to work with lecturers rather than students.

N: Do you think at the moment, lecturers are working together?

Z: Yeah. Maybe, one of our university's lecturers works with the lecturer from other university. For example, they write articles together, there are many.

N: Well, you said you are living in dormitory, what do you think of living in dormitory far away from your family?

Z: Definitely living beside your family is very good, emotionally and in all respects. If I lived with my family, they would do the work for me.

N: Like what for example?

Z: For example, cooking, washing dishes (laugh) and shopping. These are the works that I am doing by myself now. Then, I feel loneliness which is really bad. In dormitory we are all living together; therefore, we need to consider everyone's opinions and it's not your opinion only. So, we get upset, then, erm.

N: Well, how many of you are living in one room?

Z: We are five living together.

N: five in one room?

Z: Yeah.

N: I remember when I was in dormitory; we had double beds, is it like that in here as well?

Z: Yeah.

N: What about kitchen, do you have any?

Z: Yeah, we do have kitchen but it's not in our room, we have two kitchens in each floor.

N: Do you have fridge and everything in there?

Z: Yeah, we have fridge in our room.

N: How about bathroom and toilet?

Z: There are four toilets in each floor. Bathrooms are situated in basement and for each building; there are about 10 to 15 bathrooms side by side together. It's like public bathroom.

N: How is the dormitory environment?

Z: The difficulties do not bother me too much. I hurt a bit, but I easily forget, because I came here only for maths. Well, I have prioritised mathematicsover my family, so I am not like the person who force to come to Y city for studying.

N: How did you find living in Y city? Don’t you get upset?

Z: No, I do not have any problem living in Y city.

N: How many times you are going to your home town to visit your family?

Z: Every two to three months.

N: Does everyone in your room study mathematics as well? Or are they from different subjects?

Z: Actually, none of them study maths.

N: Well, do you have library for studying in dormitory?

Z: Yeah, it has study room, but someone like me can never go there to study. I have to lie down to study.

N: Oh, you have to lie down to study as well, like me, I have to lie down and study. Don’t you go to sleep after (laugh)?

Z: Either I have to lie down or to support my back like this to lying.

N: Yeah, I do have this problem and I still couldn’t fix it, first I seat for five minutes, then I lie down slowly, then I go to sleep (laugh).

Z: Yeah, exactly it same for me (laugh).

N: Well, did you say that your interest towards mathematics was spontaneous?

Z: Yeah.

N: I wanted to ask you about advisors? Did your school have any advisors?

Z: Yeah.

N: Have you ever consulted with them?

Z: Yeah, I went to the advisor to motivate me to study for national exam. I didn’t practice to do any test.

N: I had difficulty doing test as well.

Z: I didn’t like study in general. I wanted to only study mathematics but they stopped me.

N: You mean your advisors told you that don’t study maths?

Z: No, the advisors didn’t tell me don’t study maths. They told me that at the moment put mathematics aside and practice the exam test, and then when you enter to university, you would study maths. But I said I can't, I am studying one of the hypothesis now, and till I don’t finish it I can't leave it.

N: I remember I was studying too much, but when they put any test in front of me I couldn't do it. I couldn't solve any test, I don't know why? One of the reasons was that they gave us time and the given time was really stressful.

Z: Yeah, exactly.

N: I mean I mixed everything together.

Z: Yeah, test is not a good way to assess students.

N: Now, I heard that the system of national exam is going to change? Is that right?

Z: If they change it, they will bring something worse.

N: I think student's average is a good way for their entrance at university? What is your opinion towards average?

Z: No, average is worse than national exam, students come to university with less knowledge than exam.

N: Eeee. What about average with interview?

Z: Yeah, interview is very good. In my opinion anyone who goes to any subject has to be interviewed. If they had interviewed us, it would only two of us have accepted.

N: Do you think mathematics is a masculinity-subject?

Z: What do you mean by masculinity?

N: I mean your imagination toward maths, is it kind of masculinity view?

Z: Yeah, my imagination is masculinity, definitely, 99% of mathematician are men. As a lover of mathematics I know only 3 women mathematician. Among 1000 men I know only 3 of them are women. So I have masculinity view of maths. Even when I was in high school I imagined my future in mathematics as a man (laugh). I don't know why.

N: Feeling that you are doing a manly job?

Z: Yeah, exactly, because there are more men in maths.

N: Now, I am imagining that because the number of girls is more in mathematics subject, the masculinity view may not exist?

Z: My imagination from girls towards mathematics is that they come to study mathematics to get good result. They get 20 and go.

N: So, if you think girls don't like mathematics why they come?

Z: As I said before is to do with social status. Some students come in without any interest and they don't study as well. This is the fashion of going to university.

N: So, going to university is more important than the subject?

Z: Yeah, some, their family force them to come. Some, they are here because of the future career or fame, without having any interest.

N: What do you think about the relation between boys and girls at university?

Z: For example in mathematics and studying?

N: Yeah.

Z: Very very little, it's like this in Iran. There is a barrier in the relation of boys and girls. For example if we see a girl with boy, we say somethings about them. But I don't really believe in this, if I have a question I will refer to boys even from our seniors, some boys here have medal and sometimes I ask them questions.

N: I remember in our time, we didn't ask boys any questions, but now I can see that the situation is getting better, students seat and study together.

Z: Yeah, they ask each other questions, but are not very deep yet.

N: You mean they don’t work and study in a group together?

Z: Yeah, it's not that much, but I think is better than before.

N: Do you think is there any differences between male and female lecturers?

Z: If I want to say in terms of statistic, the number of female lecturers is smaller. Similar to men, there are bad lecturers among female ones too, I myself prefer male lecturers, there are of course female lecturers better than male ones but they are a few in higher levels.

N: But, in general you don’t see any difference between them?

Z: No, I don’t see any difference. Well, when I see myself as a woman who loves mathematics too much, I thought there might be other women who love mathematics and like to teach mathematics with love.

N: Well, do you know why men are reaching to the higher position but women not? I don’t know; have you ever heart about the glass ceiling? This means that women can go up to the specific level and after that their heads crash to the ceiling, but there is no such a thing for men?

Z: I don’t know since when it was like that. If we look at the past, men have always been in the good position and will stay like this in future. This may result from this fact that men have role models to follow. For example, when a boy sees a man who has reached to the good position, he likes to achieve to that position, but a girl never compares herself to a man to be like him. But if she sees a woman in a good position, she says, well, I should achieve to this position too.

N: So, you think the competition between girls is more than boys?

Z: Yeah, exactly.

N: Well, don’t you think if women reach to the high level is better, since other women are trying to reach to the same position?

Z: Yeah, I think, but I don't see any difference between them, they both men and women can reach to any level they want.

N: But, why do you think men are more successful in mathematics and can achieve better position in maths?

Z: This is something I see, I don't think, I observe.

N: Meaning that you haven't thought why these things are happening?

Z: No, I haven't thought about this issue before. When I consider others around me, I see that men have a better understanding of maths. Boys may have better understanding of mathematics but it shouldn't be like this. When I compare male and female in a class of 30 students and put myself aside, perhaps I can see only one man who is a bit better than other women in terms of understanding maths.

N: Well, don't you think that women's positions are changing gradually? I mean women are reaching to the men level as well? Like Mrs Merzakhani?

Z: It's nothing to do with history, it's not like if we move forward thing are getting better.

N: Ahan, you think is a process which is stable?

Z: No, I am saying that we cannot say that things are improving. For example because of Mrs Merzakhani we cannot predict that things are changing. Maybe there is no body like her again, so we cannot define a specific procedure for it.

N: Thanks for your time. Now I am going to make your story and I will send it to you and if I have any question I will ask you. It may take time as I have to interview 15 other students, I might send it you after New Year. Oh, something else about mathematics that I wanted to ask you. I wanted to know, have you ever thought about the relation between time and culture? I was thinking that time varies across different cultures. Einstein said that time varies across different planets. He measured time with light, and as we travel further, time is changing as well. Now if the time changes in other planets, so we can

assume that time is changing here in earth depending on different cultures? So have you ever thought about this issue?

Z: No, I never thought about social sciences, never, I don't know why? As I don't have any information about social sciences, I can't judge on them. I have always been seeking for variables to put in hypothesis and prove it. Some issues that I can't find any variables to use it and prove it, I don't think about it. So because of this reason I never have thought to give you my opinion.

N: Well, this is one of the issues that I have been thinking about for a while, but still I couldn't find any answer. Anyway thank you so much for your participation.

## Appendix 11: The survey responses of EE and mathematics students

**Table 15**: The survey responses of electronic engineer students

| | Town | Mother's education | Father's education | Mother's occupation | Father's occupation | Academic education expectancy | Future career | Q1: choice | Q2: experience | Q3: aspiration | Q4: life movie |
|---|---|---|---|---|---|---|---|---|---|---|---|
| E1 | A city | Associate degree | Diploma | Nurse | Self-employment | PhD (or maybe MSc) | Not known yet (depend on society condition) | Good grade in national exam, advisor and sister who studying electricity | Good: change for the better relating to knowledge and attitude | Financial independency as its important for women | Not known |
| E2 | Y city | MSc | B.A | House wife | Manager | Grade first to third in electronic | Working in government company | Father studied this subject, society needs and interest | Good: different era in life which will not be repeated | To do something useful for Islamic society and helping in development | 'Moving towards peace': moving to God with peace of heart |
| E3 | B city (holy city) | B.A | MSc | House wife | Lecturer in humanities | Professor in physics or engineering | Science researcher | Good grade and advisor | Both, Good: new and practical Lessons<br>Bad: studying with men and living far from family | Innovation, creating new concepts and new instruments | 'Life', life means that to move toward goals and interest. |
| E4 | Y city | | | House wife | Self-employment | MSc in Law | Lawyer | Good grade, father's interest and her own interest | Both good and bad | Learn programming and English, find a career, continue education | 'Effort', made too much effort to achieves her goals |
| E5 | C city | Diploma | B.A | House wife | Electrician company employee | Electronic | Electrician company employee | No interest, good grade and career | Good: improving social affiliation | Career relevant to electronic with good money | |
| E6 | D city | Elementary | B.A | House wife | Employee | PhD in electronic | Electrician engineering | Engaging mind, creativity and interest | Both, Good: effort to solve people's problem<br>Bad: thinking too much about issues around | Travelling, making a relax environment for herself and others and achieving desires | 'Flight': represent her life, up and down, fast and slow, broader and better view to life |
| E7 | Y city | | | | | | | Society condition | Good: gaining experience is good | Continue education and find a job | |
| E8 | Y city | Associate professor | Associate professor | Lecturer | Lecturer | PhD – Medical engineering | Medical instrument consultancy (good money) | Electronic is the nearer subject to medical engineering and be at good university | Very good: improving social affiliation, knowing different people and having good friends | Because of her mother and father she would like to get PhD, but she likes to be medical instrument consultancy | 'Doctor with outward disagreement but inward agreement', Refusing people's idea immediately but later will do it |
| E9 | Y city | Elementary | Elementary | House wife | Retired | Gaining higher level in Art | Interior designer or fashion designer | Advisor, better career, family's preference to engineering than arts | Both, Good: meeting knowledgeable people with different thinking<br>Bad: no interest in lessons | Re doing national exam in art, doing sport such as basketball and body building | 'All of my interest', she didn't follow her interest, if she followed her interest she would be more satisfy. |
| E10 | Y city | Diploma | MSc | | | PhD maybe in theatre | Choreographer or designing electronic parts | Father's preference to study engineering g than arts, interest, feeling lonely and society's need | Both, Good: participating in student activity<br>Bad: having difficulty to find friends which reduce her self-confidence | Designing shows with friends, Earning money and be independence, teaching orphan, be engineer and learn dancing | 'May never be found' or 'never be in love': anyone created for a reason. Not know the truth to be in love with |

**Table 16**: The survey responses of Mathematics students

| | Town | Mother's education | Father's education | Mother's occupation | Father's occupation | Academic education expectancy | Future career | Q1:choice | Q2: experience | Q3: aspiration | Q4: life movie |
|---|---|---|---|---|---|---|---|---|---|---|---|
| M1 | Y city | Diploma | Associate degree | House wife | Self-employment | MSc finance | Financial company manager | Like engineering but ending up mathematics | Both, Good: find good friends Bad: fail a subject and problem selecting modules | Teach English at the moment and would like to continue this in future | 'Confusion': confuse about the subject and decided to leave. There no suitable job after. |
| M2 | Y city | Elementary | Elementary | House wife | Self-employment | | Banker, private teacher or entrepreneur | To fulfill dream and to be at good university | No experience | Finding job | Dream passed, lost the dreams gradually |
| M3 | Y city | Elementary | Elementary | House wife | Self-employment | Mathematics | Lecturer and academia | Choose engineering but ending up to mathematics | Good: improving the level of social status | Continue education and working at school or company | |
| M4 | Y city | B.A Industry | B.A Mechanic | | | PhD in computer | Programming | Like computer but ending up to mathematics | Good: lessons and social affiliation are good | Learning languages, opening company or studying or working abroad | |
| M5 | Y city | Diploma | B.A | House wife | Employee | MSc in engineering | | To be at public university | Both good and bad | Teaching or working in bank | |
| M6 | Y city | Diploma | Diploma | Self-employment | Self-employment | MSc in medical engineering | | Interest, public university, ending up to mathematics and be in Y city | Bad: lecturers were not very good | Finding a job | |
| M7 | Y city | | | | | | Banker | Ending up to mathematics and be in Y city | No experience so far | Finding a job with good money | 'Impossible dreams': dreams which unachievable |
| M8 | Y city | Diploma | Diploma | House wife | Self-employment | PhD in industry or mechanic | Engineer with sport coaching | Ending up to mathematics | Both: entering to the bigger society and learning new things | Continue education and working | 'Good, bad, ugly': first was good then turn to bad then see the badness of people |
| M9 | Y city | Diploma | B.A | House wife | Employee | MSc in mathematics | Teaching | To be at public university | Both, Good: social affiliation Bad: university environment | Teaching | |
| M10 | Y city | Diploma | B.A | House wife | Retire | PhD in computer science | Researcher | Mathematics is a basic subject, interest in intellectual work | Both: the teaching methods weren't good but she made effort to be successful. | To do research but not like teaching, | 'I am not mad', she like to live in a right path but other think she is mad. |
| M11 | Y city | | | | | | Banker or teacher | Being in Y city | No experiences so far | Finding a suitable job | 'Emotion', live with her emotion |
| M12 | Y city | Diploma | Diploma | House wife | Self-employment | Art or interior designer | Engineer | A bit of interest, it wasn't the priority (ending up) | No experience | Career, education, activities like dancing or painting | 'Good, bad, ugly': same as M8 |
| M13 | Y city | B.A | B.A | Tourism industry employees | Retired from bank | PhD | Teacher or work in private company | Prefer engineering but ending up to mathematics | Both, Good: friends and lecturers, Bad: academic level and different people | | |
| M14 | Y city | Diploma | Diploma | House wife | Employee | Mathematics or physics | Lecturer | Interest and some member of family are in mathematics | Experience is experience, good or bad is vague to define | MSc in mathematics and working as a teacher | Nothing interest happen in her life to make it as a movie |
| M15 | Y city | Diploma | Diploma | School assistant | School assistant | Maybe psychology or education technology | | Interest in science and not interest in engineering | Both: all experiences have positive view | Learning many activities and arts | 'Great mistake': re doing the mistaken experience |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| M16 | Y city | B.A Social science | B.A Mechanic engineering | Social worker | Mechanical engineering | PhD in Algebra | Banker, working in stock market | Interest | Both, different and diversity people at university environment | Establish a school, banker, continue education in abroad | 'Suffering, envy, failure, simple, ignorance': experience them all |
| M17 | Y city | B.A in chemistry | B.A in management | | | Professor in mathematics | Lecturer | Interest, be lecturer and attain fields medal | Good: the academic experience | | |
| M18 | Y city | B.A | B.A | Employee | Employee | PhD, Financial management | Chief financial officer | Interest, being at good university | Good: my interest made good environment Bad: working and studying together make problem | Career, earning money and teaching | Wet eyes, recently I have been in troubles and passed difficult spring |
| M19 | D city | Diploma | Associate degree | Archive officer at medical university | Retired from education | Mathematics | Teacher | Interest, good university at the good geographical condition | Both, regret and proud of her choice, there were some challenges which made her to think this way | Engaging with the exchange company, private teacher or continue education to be a lecturer | 'I am only a student': sometimes lecturers and students forget about this which make challenge |
| M20 | E city | | | House wife | Self-employment | Mathematics , attain fields medal | Lecturer | Love and interest | Bad: the university's environment, lecturers and students don't like mathematics . | Continue study in mathematics , lecturer, writing about the famous mathematician | 'Virtual mistress', mathematics is a living creature which she lives with it |