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Gender-STEM Stereotypes: A Cross-cultural, Mixed-methods Exploration of Women's STEM Pathways between the UK and China

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Abstract

Women's underrepresentation in higher education and careers in science, technology, engineering, and mathematics (STEM) fields remains a persistent global problem. Grounded in social psychological theories related to gender stereotypes, this cross-cultural thesis aims to understand the reasons for British and Chinese women's underrepresentation. A review of existing empirical research highlights gaps in understanding British and Chinese women's underrepresentation in STEM disciplines and careers identified gaps into why and how women maintain careers in these fields. Therefore, this study aimed to 1) identify British and Chinese women's explicit and implicit gender-STEM stereotypes and the factors impacting these stereotypes; 2) explore what factors positively influenced women studying to PhD level in STEM fields; 3) investigate and interpret patterns of how Chinese Eearly career researchers (ECRs) achieve in their STEM fields. A sequential explanatory mixed-methods design was conducted. The first phase used a quantitative survey and lab-based Implicit Association Test to compare the explicit and implicit gender-STEM stereotypes and attitudes toward STEM fields of British and Chinese women (n = 113). Using a 2 x 2 ANOVA design, Chinese women in the cohort had higher explicit gender-STEM stereotypes than British women, and women studying in STEM fields had lower explicit attitudes on STEM subjects than women not studying in STEM fields. There were no significant main effects or interactions of nationality and STEM study on the implicit measure. However, a planned independent contrast found that Chinese women studying STEM subjects had lower implicit gender-STEM stereotypes than women not studying STEM. The second phase included qualitative focus groups with women from the UK (n= 5) and China (n= 6) studying STEM in the UK, and interviews with Chinese women working successfully in their STEM fields (n = 4) to more deeply understand why women's persistence in higher level education and careers in STEM. Analyses uncovered factors influencing women's attrition in STEM fields and possibilities for how women could maintain and achieve at higher level of education and careers in STEM fields. This mixed-method, cross-cultural, and interdisciplinary thesis makes a significant contribution through uncovering common barriers to STEM fields, women's cognitive dissonance regarding gender-STEM stereotypes, and cultural differences suggesting "glass ceilings" effects in the UK and the pressures from the "ground floor" from Chinese family and society. Policy and educational recommendations are provided, including the importance of embedding STEM career knowledges early, policies such as flexible working, successful female role models in STEM, and the role of social media in raising women's career profiles and widening their networks.

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This PhD journey has been a life-changing experience, and one that I might never have the chance to repeat. There is no doubt that without the great support and help I have received along the way, I would not have been able to make it to the end. Therefore, I would like to offer my heartfelt thanks to everyone who has helped me throughout this journey.

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This thesis is also dedicated to myself for being persistent and my loved ones.
A special thank you to my fiancé, Abyss, who has been such a comfort to me. You made this journey the most precious and unbelievable memory, and one which only you will be able to share with me one day in the future as my alumnus. Last, but not least, my deepest thanks to my darling parents who never fail me and always believe in me. I will love them with all my heart forever.

AUTHOR’S DECLARATION

“I declare that, except where explicit reference is made to the contribution of others, that this dissertation is the result of my own work and has not been submitted for any other degree at the University of Glasgow or any other institution.”

Printed Name: ____LIU JIANSHU__________ Signature: _______ __________

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1. CHAPTER ONE: INTRODUCTION

This chapter will present an overview of the thesis. It will introduce the background story to this research (Section 1.1), outline existing gaps in the literature (Section 1.2), followed by the research questions and aims (Section 1.3), theoretical and empirical framework, key terms, and methodological approach that will be used (Section 1.4). Section 1.5 will provide an overview of the thesis structure. The chapter concludes with a brief statement on researcher positionality and reflexivity (Section 1.6).

1.1 Background to the Thesis

What makes a woman memorialised in history? Dame Susan Jocelyn Bell Burnell was one of the women who broke into the traditionally male occupied physics world, becoming the first female president of the Institute of Physics from 2008 to 2010. Dame Bell Burnell graduated with Honours from the University of Glasgow in 1965 with her bachelor's degree in physics and completed her PhD in Radio Astronomy at the University of Cambridge in 1969. She discovered the first radio pulsars in 1967 (Burnell, 1977) but there was controversy on the issue that she might be the recipient of the Nobel Prize in 1974 (Tesh & Wade, 2017). Despite doubts and barriers along her career path, often due to her being a woman, she kept pursuing 'male' work instead of becoming a traditional housewife. For instance, she became the only female student in her physics class and she continued to help women in her field by raising funding in physics. In China, another remarkable woman, Tu Youyou, won the 2015 Nobel Prize in Physiology or Medicine, jointly with William C. Campbell and Satoshi Ōmura. She discovered artemisinin and dihydroartemisinin, which saved millions of lives around the world from Malaria (NobelPrize, 2024). Tu was the first Chinese female citizen to win the Nobel Prize, and the very first native Chinese scientist[1] to win this Prize in history, despite having no postgraduate avenues of study during her education (Congratulations, 2015). Both Dame Bell Burnell and Tu paved the path for women leaders and innovators in science, technology, engineering, and mathematics (STEM). However, to date, there remains a worldwide phenomenon of women's underrepresentation in STEM fields. Therefore, the present research

[1] Tu carries her research exclusively in China.

seeks to explore the main barriers and facilitators of women's educational and career journeys in STEM, using mixed-methods data, and considering both a Western UK context and an under-researched Chinese context to address the disproportional attrition of women in STEM careers.

1.2 Gaps in the Literature

Despite the improvements in women's equity over many decades in the UK and China, women in both countries continue to suffer sexual discrimination and stereotyping, which means they are under threat of stereotyping and experiencing gender stereotypes. In the UK, women face more problems in terms of career promotion and job segregation (e.g. the glass ceiling). Chinese women face the same issues as UK women but are also still deeply impacted by traditional Chinese culture (such as the long-entrenched traditions of Confucianism), which contains gender stereotypes (e.g. good wife) that obstruct women from achieving equity. Existing literature shows that Chinese studies into gender equity (e.g. women's underrepresentation in STEM fields) share many similar patterns with Western studies, albeit the former indicating a stronger cultural impact (e.g. Chinese women's gender roles are affected by Confucianism).

Although the gender gap in STEM fields have improved at the lower levels of education in the UK (OECD, 2018), the so-called narrowing of the 'STEM pipeline' persists at higher levels of education and into STEM careers in both the UK (Autumn Budget 2017, 2019) and China (Chinese Campus Recruitment Report, 2018). In other words, women remain underrepresented at higher levels of postgraduate education and skilled employment as women in STEM fields tend to quit or leave these areas in greater proportions compared to non-STEM fields (HM Treasury, 2017; OECD, 2018).

Various disciplines have applied different methods to understand women's persistent and pervasive underrepresentation in STEM fields, empirically studying phenomena from personal factors influencing women (e.g. motivation, self-beliefs) to potential influences from the environment (e.g. role models, families, schools, national culture; Kapitanoff & Pandey, 2017). Gender stereotypes and beliefs shaped by the process of gender socialisation have been one guiding paradigm to explain the STEM gender gap phenomena (e.g. Tenenbaum & Leaper, 2002). However, there are research gaps in these attempts when it comes to both British and Chinese empirical research literature.

For instance, most existing approaches have tried to answer why women are not entering STEM fields in primary, secondary, and higher education levels. Addressing why women are underrepresented in STEM fields might not address maintenance and progression of women in these fields, but increasingly researchers are exploring the ‘how’ and ‘where’ of the alleged ‘leaky pipelines’ of women leaving these fields of study and employment. However, there has been less focus on attrition of women from STEM fields at later levels, such as postgraduate study and skilled STEM-relevant employment. In other words, researchers have rarely employed a holistic view of women’s participation in STEM fields using a whole pathway perspective as existing research tends to focus more on one level of study, rather than transitions between levels and into/within skilled employment.

Likewise, previous research has primarily explored explicit sexism and gender-related prejudice. Less research has focussed on implicit and internalised gender-science stereotypes, which may also have a profound impact on women and impair their STEM career choices and aspirations, leading to less progression into and greater attrition within these fields. In terms of comparative research, research on women’s underrepresentation in STEM fields have largely focused on examining cross-national variation in achievement (e.g. math ability) and researchers have limited knowledge of cultural context differences, such as between the UK and China.

Therefore, this PhD research will address the aforementioned gaps by focusing on women studying and working in STEM fields from the UK and China and the barriers and facilitators these women have faced, to shed light on women’s continued underrepresentation and participation and in STEM fields. In addition, both implicit and explicit stereotypes will be explored, as well as more in-depth qualitative lived experiences concentrating on how women might achieve and sustain careers into higher levels of education and/or careers, particularly when there is a will or desire to achieve STEM-related life goals. Based on all gaps above, I will give research aims in the next section.

1.3 Research Aims

Overarching aim 1: Identify implicit and explicit gender-STEM stereotypes and possible factors that influence women in STEM in the UK and China.

Overarching aim 2: Explore factors that positively influence women's decisions to study STEM leading up to their postgraduate studies in the UK by identifying the key facilitators, barriers, and transition points that retained both UK and Chinese women's progression in STEM at the postgraduate level and beyond.

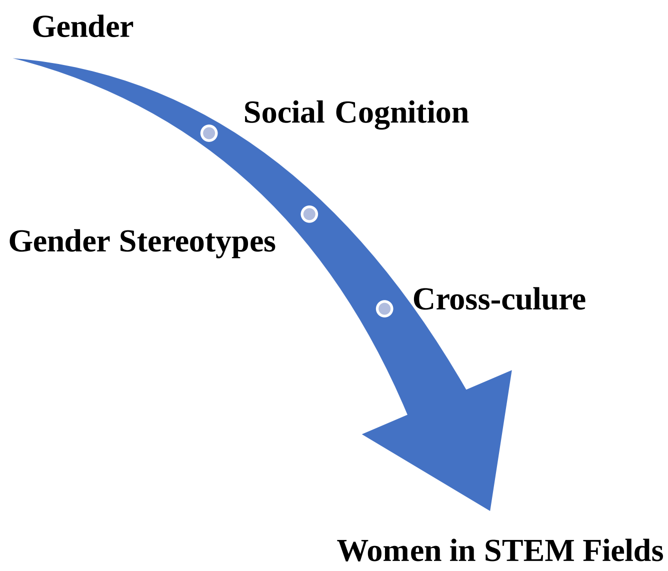
Overarching aim 3: Investigate the underlying factors influencing Chinese women's decisions to pursue and maintain high-level STEM careers in the UK, considering wider cultural and family influence on career progression and maintenance.

Overarching aim 4 (Triangulated findings): How are Chinese women's work-life tensions, and more generally their internal-external motivations, influencing factors in achieving and maintaining successful career in STEM fields.

1.4 Theoretical Framework and Methodology

This section will lay out the perspectives underpinning the research. Figure1-1.1 illustrates the theoretical and disciplinary progression of the thesis from broad conceptions of gender, sexism and feminism in the wider social science landscape, to more specific conceptions of gender, prejudice and discrimination within a social cognition context, including implicit notions of gender stereotypes considered within cross-cultural contexts and focusing on women in STEM fields.

Figure 1-1.1: Theoretical Framework Guide



As a construct, gender is can be poorly defined by laypeople due to its complexity and pervasiveness in daily life. Much sociological literature discusses gender as a process – i.e. ‘doing gender’. Guided (or directed) by social institutions, social structures around biological sex is built through associated gendered traits and roles. In other words, gender is created in a culturally-specific process, which leads to social differences that culturally define women and men in social interactions (Scott, 1999; Howes, 2002). Gender is therefore considered by some to be ‘performative’, or an act, rather than ‘acquired’, such as being born with male or female chromosomes and anatomy (e.g., Butler, 2014). Butler (2014) argued that gender is neither ‘replicated in rote fashion’, but rather (re)produced by behaving in ways learned as appropriate for their gender (role) and social status. However, Butler presents the alternative to the performativity of gender by resisting or rebelling against such norms (Butler, 2014).

Social psychologists also acknowledge the process of gendering by viewing the person as function of the individual within the environment (Bandura, 1977). They see gendering as part of developmental learning under the social context; that is, the developmental structure of family and community interact with how individuals achieve ‘gendered identification’. Within the more specific sub-discipline of social cognition, individuals’ cognitions are a process of one’s thinking within the environment (and the impact of the environment on one’s thinking), leading to more specific notions of gender schema, gender self-schema, and gendered identification which reaches far beyond simple gender expression (Fiske and Taylor, 1991; Liben and Signorella, 1980; Tajfel and Turner ,1986).

In addition to sociological and social psychological lenses, it is important to acknowledge biological and evolutionary perspectives that use biological sex differences as a basis for traditionally affiliated gender traits, roles and social expectations. However, since biological sex differences cannot explain the STEM gender gap, that is, no systematic global sex differences are found for women achieving differently on their STEM study; biological and evolutionary perspectives will not feature heavily in this thesis. Instead, a social psychological perspective which underpins the development gendered attitudes and discrimination from theories of stereotypes in social cognition will guide this thesis.

Gender stereotypes have been discussed for several decades to understand gender inequality and women’s underrepresentation in education and careers, analysing such issues as job segregation, “glass ceilings” for women, and female pipelines as professionals in science. While no specific theories can entirely explain stereotypes, this thesis will highlight three main theories applied to understand stereotypes: social identity theory, social cognition theory, and social interference theory, which address stereotypes in terms of information categorisation, information processing (schema), and social influences on stereotypes (Tajfei & Turner, 1986; Fiske & Taylor, 1991). Additionally, since stereotype research has started to emphasise the cultural perspective to shed light on the social nature of stereotypes (e.g., Moscovici, 1973; Hinton, 2013) this thesis will also explore cross-cultural perspectives to interpret gender stereotypes by discussing culture as an essential factor shaping stereotypes as highlighted by social representations theory (Moscovici, 1973).

STEM is an acronym for Science, Technology, Engineering and Mathematics. It is a multidisciplinary area that has been widely discussed in educational and psychological research on gender disparity in social issues. Current social psychology and social cognition research indicates that gender stereotypes may be one of the main factors explaining the disparity in gender achievement in STEM. Gender stereotypes include gender beliefs and stereotypes about women that disadvantage women. This thesis focuses on how gender-STEM stereotypes (gender stereotypes related to the STEM fields) may influence women's attitudes and behaviours and impact on women's representation or presentation in STEM fields.

Contemporary psychologists define attitudes and beliefs with specific approaches, thus the evaluation of behaviours and beliefs to members in certain groups would separate different components as (1) stereotypes, (2) prejudice, and (3) discrimination. These three key terms will now be briefly discussed in relation to this thesis.

For psychologists, particularly social psychologists, ***Stereotypes*** are thought of as "pictures in our head" (Lippman, 1922, p. 16), where a demographic group have labelled associations, beliefs and opinions attributed to them (e.g. characteristics, traits, behaviours). These associations may be gathered or absorbed by people's own observation or influenced via certain people (e.g. peers, parents, teachers) and social environments (Hilton & von Hippel, 1996). The accuracy of stereotypes can depend on different factors in various situations (e.g. Hamilton College, 2003; Nelson, 1986). Stereotypes are generalisations and therefore not necessarily correct nor incorrect. Stereotypes can be both descriptive and prescriptive at the same time (Prentice and Carranza, 2002). That is, people holding certain stereotypes about particular groups use stereotypes to describe what characteristics the groups have, but also use them to predict how people in the group should behave. Although stereotypes can be positive as well negative, psychologists more often research negative stereotypes (Allport, 1954). Psychologists view stereotyping processes as an unavoidable by-product of categorising our social world in order to deal with all the information we have to process on a millisecond basis (Hilton, 2000). In contrast to the more 'cognitive' component or mental structures of stereotypes, social psychologists tend to view ***prejudice*** as being more focused on people's 'feelings', that is, when people interact with people from other groups, emotions are directed towards people partly because they are part of a social group (Brewer, 1999). Therefore, prejudice is the 'affective' counterpart of stereotypes, and can also be positive or negative in valence. On the other hand, ***Discrimination*** concerns behaviour toward people based on their group categorisation. That is, treating other people differently because they are from a social group different from one's own (Sue, 2003).

In brief, social psychologists define stereotypes as cognitive, prejudice as affective, and discrimination as behaviours (individual or institutional policies and practices). For this thesis, which is focuses on exploring the cognitive mechanisms underlying women's underrepresentation in STEM fields at HE level and beyond, only stereotypes will be widely and thoroughly discussed. However, prejudice in the form of internalised sexist attitudes is also explored, in terms of women's explicit attitude towards this phenomenon. To further explore how potential affective factors and environment develop around implicitly developed cognitive stereotypes, combine in this thesis to unpack the underlying reasoning explanations of gendered inequalities in STEM from a primarily social psychological perspectives, leading to behaviours implications for policies and institutional practices in the real world.

This thesis utilises a mixed method sequential design involving three studies across two phases. Each study was designed to address particular Overarching Aims outlined in the previous section. Guided by social cognition theories, the main aim of the quantitative Phase 1-Study 1 of the thesis was to identify implicit and explicit gender-STEM stereotypes and the possible impacts of such internalised gender stereotypes on women's underrepresentation in STEM fields in the UK and China (Overarching Aim 1). Using Social Identity Theory (SIT; Turner &

Tajfel, 1979) as a lens, the qualitative Phase 2-Study 2 explored experiences of gender-STEM stereotype development and barriers for women who have achieved success at the highest levels of Higher Education (namely researching PhDs) in STEM fields, considering cultural differences in both countries (Overarching Aim 2). Finally, qualitative Phase 2-Study 3 built on Study 1 and Study 2 results to explore the lived experiences of Chinese women working successfully in their chosen STEM fields in the UK (Overarching Aim 3). Applying a cross-cultural perspective, triangulated findings (Overarching Aim 4) were used to summarise patterns of STEM participation for British and Chinese women by critically applying the 'leaky pipeline' analogy to explore the trajectories of women who succeed in STEM fields and the facilitators to overcoming barriers at key transition points for women studying and working in STEM from the UK and China.

The sequential exploratory design details are summarised in *Figure 2-1.2*. Phase 1 (quantitative approach) used both implicit association tests and questionnaires to explore implicit and explicit gender attitudes about women in STEM fields. According to the dual-process model (Evan & Stanovich, 2013), information processing takes place in two directions simultaneously. It can be argued that when information is processed by humans, these two processes (implicit and explicit attitudes) predict two different behaviours in two attitudes constructs (Greenwald & Farnham, 2000; Cunningham et al., 2001). Those relationships are primarily spontaneous and deliberate in nature in the dual-process model (Fazio, 1990; Fazio & Towles-Schwen, 1999). Explicit measurements used to assess sexism and feminist identity (Thompson, Pleck & Ferrera, 1992) have changed over time. The scale used to assess explicit gender-STEM stereotypes was introduced by Jackson, Hillard, & Schneider (2014). This questionnaire was deemed suitable to access women's explicit attitudes towards STEM fields. Since detecting stereotypes can be problematic due to self-report bias, incorporating implicit measurements can provide a more comprehensive way to understand the information processing within social cognition (Greenwald & Banaji, 1995). Moreover, the combination of implicit and explicit measurements is stronger than single measures (Nosek & Smyth, 2007). The Implicit Association Task (IAT) was used to detect implicit gender-STEM stereotypes through the automatic associations between STEM attributes and gender. The IAT was selected given its validity and reliability in measuring implicit stereotypes (Bar-Anan et al., 2009).

Based on Phase 1 results and the literature, Phase 2 (qualitative approach) protocols were designed. Since Phase 2 involved women studying and working in STEM fields from the UK and China, conducting focus groups and interviews were deemed suitable. Focus groups were applied as they are all students (staying in the UK) and thus share some commonalities, whereas the interviewees are unique and diverse in their STEM careers. As Figure 1-1.2 shows, focus groups data were analysed using themes analysis (TA); while Interpretive Phenomenological analysis (IPA) was used for the interviews.

Figure 2-1.2: Flowchart of Sequential Exploratory Design.

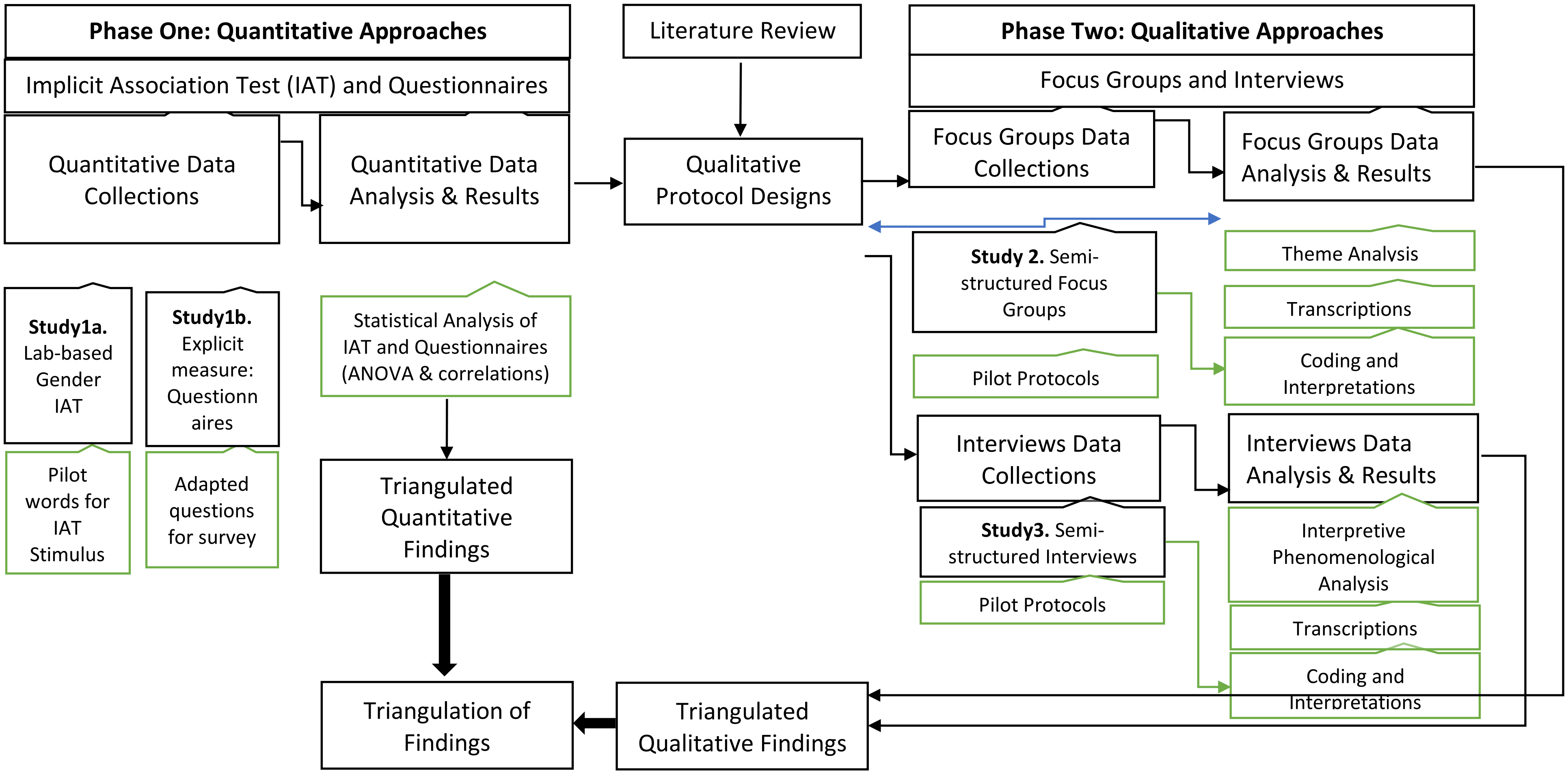
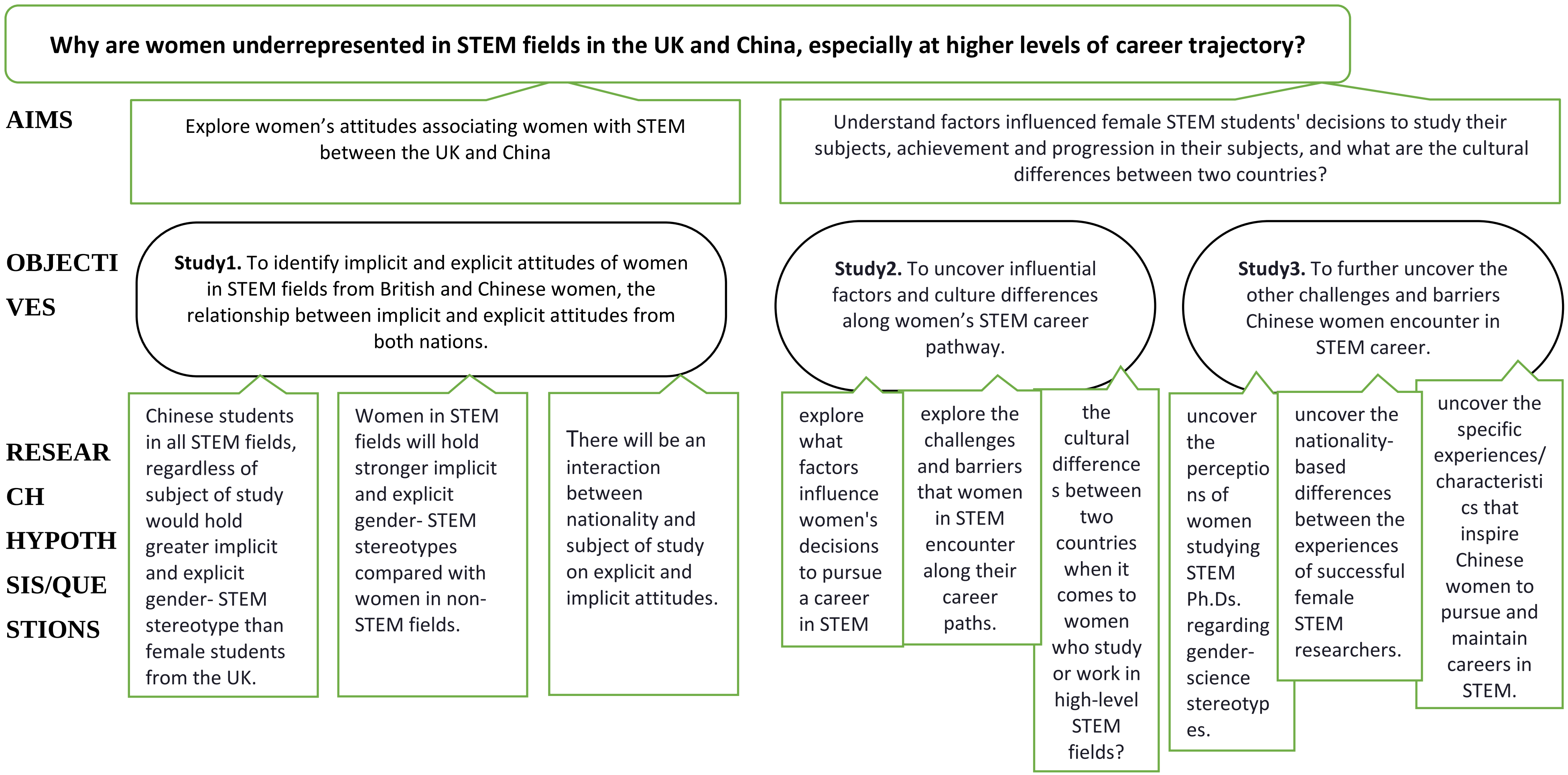


Figure 3-1.3: Research Hypothesis and Questions in Two Different Phases



1.5 Overview of the Thesis Structure

This Chapter One provides an introduction and overview of the thesis. Chapters Two and Three present relevant social psychological theories and research literature, respectively, on gender stereotypes and women's underrepresentation in STEM fields, highlighting social issues relevant to feminism between the UK and China. Chapter Four provides an overview of the quantitative and qualitative approach used in this thesis, explains how a mixed method sequential design was carried out in this research, and states the formal research questions and objectives. Chapter Five presents the Phase 1 quantitative research Study 1 design, analyses, and results. This is followed by the presentation of Phase 2 qualitative research Study 2 (focus groups with UK and Chinese students) in Chapter Six. Chapter Seven then presents Phase 2 Study 3 (interviews with Chinese students). Finally, Chapter Eight concludes the thesis with a triangulated discussion of findings and its implications for gender equity in STEM education institutions and national level policies in the UK and China.

1.6 Positionality: Researcher Reflexivity

This section will be a personal reflection of my experiences within the whole thesis process, which is related to my whole PhD journey. Literally, mine was a pathway of combination between being a Chinese woman and doing a PhD in the social sciences. My experiences were often very similar to those I discussed in this thesis, as the whole story was about the combining crises of being a Chinese woman pursuing higher degree studies, alongside issues of not being married in traditional Chinese culture. Some key breakdown moments have led me to think of this PhD on deeper levels rather than just simply as a degree of study.

The first breakdown period was when my previous male supervisor left without notice, and I could not progress at the end of the first year of my PhD – even though I had prepared all the experiments and was ready to collect data on the agreed topic of evaluating how women's period affected her cognitions. When my initial supervisor left, he took all the relevant equipment, including the computer on which I had programmed my study, without giving any notice. Without any equipment, I obviously could not continue on my own. But more importantly, I reflected on whether I was truly interested in the initial research topic. In other words, I needed to restart and I needed others' help. Luckily, I found my current supervisors and they both were very supportive, not only as supervisors, but also as my own female role models in academia as well, both coming from a social science background but open to discussing their own work-life balance issues.

This topic was co-inspired by my supervisors and my curiosity of cross-cultural comparisons stemming from my own experience. To me, this topic was new and I was devoted to it, as I felt that I am part of the topic itself. When choosing participants, I felt some science subjects were particularly hard to classify as STEM or not. For instance, with psychology – some defined it as 'soft science' and therefore outside STEM. However, we know psychology has many branches, which apply diverse methods and techniques. This led to my own 'identity struggle', as I always considered myself as part of the STEM community. Yet the women I recruited were from the 'hard science' backgrounds to represent the STEM fields where under-representation happens more heavily.

The most critical issue for me was how my orientation to family changed and how the PhD impacted me along this journey. As a Chinese woman, we may feel we need to follow certain potential 'rules' in the society, which is why we may like to 'escape' - with family support - to study abroad. As my PhD started, my family began to worry about my marriage, even before discussions of a job. This came to calm when I found a fiancée. However, they still kept pushing me to marry as soon as possible, and to have a child just after this. This pressure felt endless as I was struggling and wondering what's going on and where was the pressure coming from with these extra worries. Finally, the conflict of cultural differences emerging from my thesis, offered me a possibility for understanding this. Not only from what I saw here around me – mostly from my female peers, but also from both of my supervisors who are lecturers, mothers and wives. This made me see possibilities and feel less burdened, but also worried about whether this could be achieved in China.

Many of these concerns emerged in my thesis at various points, despite my precautions to remain objective in order to allow the data to speak for itself. As I discussed in the Phase 2 analyses, however, perhaps my experiences helped me identify the themes more quickly and to better hear the stories emerging. Writing the discussion in my thesis helped me think through the self-concept of my own career, gender identity within my family, and be more reflective of my life goals. It is a rare chance to see how profoundly one's culture impacts on your sense of self in different countries and different perspectives outside my own subject of study's view.

I finished my final discussion and overall draft amid the Covid-19 crisis at the beginning of 2020 till 2022. Being from Wuhan - the original epicentre of the pandemic – it has been such a harrowing feeling to have to write a thesis and be terrified at the same time. My family were in the centre of this pandemic and as it went through the world, finally arriving in the UK, I had to finish writing this thesis in lockdown, away from friends and family. This most complex and intensive feeling might be seated in my memory forever, but hopefully it will not have to happen again. At last, I am heartened by my PhD research, and would like to add some final advice from my participants, as they were passing key messages for women in academia like me, and like us: "to be a woman - be true to yourself". In times of crisis, in particular, this message rings true for me, and my future as an academic, wife, and someday mother. I will carry this message from my participants in my heart.

2. CHAPTER TWO: GENDERED DEVELOPMENT, STEREOTYPES, AND INEQUALIITIES

This chapter will discuss gender in social constructions (Section 2.1), distinguish gender and sex (Section 2.2), and provide a brief overview of sexism and stereotype theories development (Section 2.3). The chapter concludes with a discussion of gender issues and research around STEM, focusing on women's underrepresentation in STEM (Section 2.4).

2.1 Gender in Social Constructions

Gender is widely discussed in social science research and has been since the early 19th century with reviews and discussions about gender and sex, gender role and representations, appearing in academic publications (e.g. Miles, 1935) and the launch of the Psychology of Gender wing of the American Psychological Association (APA) and the British Psychological Society (BPS) in the 1940s. However, the term 'gender' outside the field of psychology remains complex and poorly operationalised by lay people, as it is so familiar and easy to ignore in social life.

Although this thesis is developed from a social psychological framework, it is worth acknowledging the work of sociologists in introducing the 'performative' nature of gender as something we 'do' (e.g., Butler, 2014). For instance, Lorber (1991) explains this gender process as a social institution through which "human beings organize their lives" (p. 113). Gender might have never been noticed by people unless gender is ambiguous (Lorber, 1991). Individuals are not only identified as a man or woman by physiology, but also by social identification and presentation, and people with social dislocation might change how they look, dress or even their biology to 'fit' into a gendered group of women or men.

In psychology, I think of this in terms of the primacy of the gender schema in society. Gendered constructions are assigned to boys and girls with associated gender bias just after they are born – e.g. seeing baby boys in blue and baby girls in pink in advertisements (Pomerleau, Bolduc, Malcuit & Cossette, 1990). This can also be seen in how parents name, dress and influence their children to follow the socially proscribed gender rules based on their physiological gender – (Peterson & Hann, 1999; Wong & Hines, 2015). Children's behaviour might act in line with these gender expectations and gender becomes learnt gradually (Eagly, 1987; 1997). In other words, gender differences will emerge on many levels from early childhood (i.e. widely agreed approximate age as early as 3 years old) until adulthood (Bukatko & Daehler, 1995).

As social institutions, the social structures around biological sex and associated gendered roles are built on unequal statuses. As a process, gender creates social differences that culturally define ‘woman’ and ‘man’ in social interactions throughout their lives. Individuals learn what is expected, how to act and react in expected ways, and simultaneously construct and maintain the ‘gender order’. As Butler (2014) puts it, "the very injunction to be given gender takes place through discursive routes: to be a good mother, a heterosexually desirable object, to be a fit worker, in sum, to signify a multiplicity of guarantees in response to variety of different demands all at once." (p. 145). Members of a social group neither ‘make up gender’ nor exactly ‘replicate it in rote fashion’, instead sociologists like Butler argue that in almost every encounter, human beings (re)produce gender by behaving in the ways they learned were appropriate for their gender role and status, or by resisting or rebelling against these norms (*Ibid)*. Resistance and rebellion have also altered gender norms, across cultures and over time, but so far, they have rarely succeeded in fully eroding societal gender roles and statuses (*Ibid)*.

It has been argued by sociologists and social psychologists, that everyday gendered interactions ‘build’ gender into the family, the work process, and other organisations build gender into a family, the work process, and other organizations and institutions, which reinforce gender expectations for individuals. Because gender is hypothesised as a process, “there is room not only for modification and variation by individuals and small groups but also for institutionalized change” (Scott, 1999, p. 7). In other words, ‘gender’ is a processing over time, largely modified and changing by society influences to finally achieve individuals’ gender identity and status.

As part of a social ‘stratification system’, gender ranks men above women of the same race and class in most societies (Scott, 1999). Women and men may in theory be classed as different but equal - such as in law, the right to vote and work (e.g., The 19th Amendment), but in practice, the process of creating difference depends on ‘differential evaluation’, which means differential treatment for women and men on the same issue. As Jay (1981) says: "that which is defined, separated out, isolated from all else is A and pure. Not-A is necessarily impure, a random catchall to which nothing is external except A and the principle of order that separates it from Not-A" (p. 45). From a social psychological view, we may consider this as ‘othering’ (Fiske and Taylor, 1991) or out-group differentiation derogation.

In summary, sociologists, such as Lorber (1991) and Butler (2014), address gender as a whole process with many social interactions within a hierarchical social structure. Social psychologists, on the other hand, acknowledge the person as a function of the individual within the environment (Bandura, 1977) - focusing on the developmental structure of the family/community, and the individual process of ‘doing’ gender, gender schemas/self-schemas and gendered identification. In social institutions, gender is part of the process of social distinguishing to responsibility and rights, however that is not the focus of this thesis. Thus, from this perspective, the suggestions and interventions might build upon the gendered schema outcomes of social constructivism, whilst acknowledging biological difference, to help tackle equality in the specific area of STEM study.

2.2 Gender, Sex and Differences Research

Gender and sex should always be considered together. However, it should be noted that they are different concepts[2]. For most psychologists and sociologists, the term ‘sex’ applies to

[2] Although this thesis acknowledges that biological sex is not binary, the survey sample only had 2 respondents who self-identified as trans women. Likewise, the interview sample only had participants who self-identified as being biologically-born female. Therefore, this thesis is only able to focus on the experiences of women biologically-born and self-identifying as women. The need for more critical reviews of trans women, non-binary persons and other sexual and gender minorities in STEM is addressed in the discussion.

biological features (including genetic and physiological markers) to distinguish a female or male human. On the other hand, 'gender' refers to "a set of traits, behaviors, and expectations that cultures train girls and boys to practice and hold" wherein biology becomes associated with 'masculine' and 'feminine' traits (Howes, 2002, p. 25). Put another way, gender is ''the cultural meaning we construct around what it means to be male or female'' (Rennie, 1998, p. 952). In other words, gender is not limited to biological features but rather assigned by 'social construction' and could therefore change (Howes, 2002). Gender particularly attributes associate with one sex or the other, which is "normal" or standard. This limits the board of single sex, leading to discrimination, stereotypes to certain sex group. In general, the predominant view in social science research is to consider biological differences as an underpinning catalyst for the social process of gendered construction; however, neither is considered binary nor a pre-destination (e.g. Butler, 2014; Gould, 1977; Unger, 1979; Unger & Crawford, 1992).

Although this thesis does not intend to explore physiological or brain-based differences in explaining differential STEM participation, it is worth acknowledging research suggesting biological differences between those chromosomally categorised as male and female. However, it is important to note that much of this research is based on 'mean differences' (MD), which means that results are based on standard statistic measurement – e.g. measuring the absolute difference between the mean value in two groups in a clinical trial and estimating the amount by which the experimental intervention changes the outcome on average compared with the control group (Higgins and Green, 2008). In other words, researchers can only compare these groups within their contexts and under certain conditions (e.g. nationality, age, social class pattern, etc.), but these comparisons will not represent the whole of 'a sex'. While the focus of this thesis is not on biological differences in cognition in different STEM areas, should and if they exist, but on the significant social influences that may shape gendered attitudes and beliefs around going into STEM careers; it is worth noting that physiological evidence seeking to prove or disprove sex-based intelligence differences might itself lead to further stereotyping and discrimination attributed to sex differences.

On the whole, physiological research documents a difference of brain volume when looking at humans as young as two weeks old, with about 8% sex difference in total (Charman, Baron-

Cohen, Swettenham, Baird, Drew & Cox, 2003). When looking at different parts of the brain, different regions of the brain tend to show average differences between the sexes. For instance, some research indicate that female brains tend to have larger language centres than male brains (on average) (Kimura, 1999). While others show differential brain activations with women remembering more emotional stimuli (Halpern, 2000), as well as differences in neurochemistry with male brains producing 50% more serotonin than female brains (Baron-Cohen, 2004). While differences in brain size, structure/functionality, and neurochemical make-up do not necessitate societal differences, such as those seen in STEM participation, it is worth considering the extent to which such differences may be involved in academic participation and achievement. For instance, it has been hypothesised that sex hormones could affect some cognitive performances related to math and science, which may be beneficial for some tasks in math and science disciplines (Irwing, 2006). However, some research suggests that men and women have equal 'aptitude' or 'natural ability' for math and science and that individual differences far outweigh average differences based on biological sex (Spelke, 2005 for a review). Similarly, the intelligence quotient (IQ), which has often been used used to hypothesise intellectual differences between boys and girls (Share, McGee & Silva, 1989) is not without critique. Debates about sex differences on standardised measures of intelligence, such as PISA (Irwing & Lynn, 2006), are showing less consistent maths/spatial and verbal sex-based split globally, with most experts agreeing that gender roles and gender-based play may be responsible for both the initial gap, and the subsequent levelling out of sex-difference on spatial tasks (e.g. Sternberg, 2011). In fact, some researchers conclude that boys and girls tend to have equal cognitive abilities, with different profiles in terms of the specific tasks they are better at on average (Pinker, 2002; Andrew, 2008).

In brief, the research on biological differences is complex and mixed as even those that find differences tend to find that these differences are very small. Therefore, most psychologists conclude that there are no significant biological differences that indicate sex differences in terms of cognitions, and certainly none with implications for academic study. In particular, this thesis argues that even if biological (sex) differences were consistently and globally evidenced, this would not indicate that differences existed between all women and men - but rather, only an average mean difference with greater variance within women and within men than between. Thus, the focus of this thesis is on the process of becoming gendered rather than on biological differences in brain structures or IQ. For this reason, biological/sex differences will not be further expanded in this thesis. Instead, using a social psychological lens, it will expand further on the self-perceptions of cognitive abilities and resulting socialised behaviours of human beings and the role they play in gendered inequalities in STEM.

2.3 Stereotypes, Sexism and Gender Attitudes

2.3.1 Early Studies of Stereotypes

Research on stereotypes has occupied psychologists since the 1920s and spans more than 90 years. Psychologists have studied various aspects of stereotyping - from the formation of stereotypes, to the cognitive processing of stereotyping, to how stereotyping relates to other factors (e.g. language and culture). Lippmann is commonly believed to have been the first psychologist to study stereotyping within the social sciences when he published the book *Public Opinion* in 1922. In this book, he introduced the concept of the stereotype and discussed how and why stereotypes are used. On the whole, Lippmann (1922) formed the key arguments of stereotype research and inspired subsequent studies in this area.

Lippman (1922) considered stereotypes to be a “picture” of people and the events of the world (p. 3). That is, he argued that since the world is too complex, we deal with our environments through “pictures” that we construct, and the ways we act are based on the “pictures” we form of a given situation. Lippmann further holds that these “pictures” are designed by the person or given by their culture (p. 25). He particularly highlighted the importance of culture when he said “…In the great blooming, buzzing confusion of the outer world we pick out what our culture has already defined for us, and we tend to perceive that which we have picked out in the form stereotyped for us by our culture” (Lippmann, 1922, p. 81). He goes on to argue that stereotypes - both the process of producing them and their contents - are essentially false and yet they are resistant to change (p. 98).

To summarise, the key points of Lippmann's (1922) research are: (1) stereotypes derive from the limitations of human cognitive processes – that is, we turn our perceptions and knowledge into simplified "pictures" of the world; (2) the contents of stereotypes come from the culture surrounding the person; (3) both the process and content of stereotyping are faulty because this process produces incorrect "pictures" of the world; (4) the negative contents of stereotypes and stereotyping are inflexible and hard to change. After Lippmann (1922) followed a number of key studies in social psychology that focused on exploring the common contents of stereotypes. For example, Katz and Braly (1933) adapted the trait checklist as a paradigm for examining the contents of stereotypes. They applied this checklist in a study involving 100 students who categorised ten different ethnic groups (e.g. Italian, English, German, Jews, Blacks) using a given list of 84 descriptive adjectives (e.g. intelligent, artistic, industrious, passionate, conventional, conservative). Participants picked five characteristics for each group and the results showed a high level of consensus regarding the characteristics attributed to certain groups of people, thereby indicating a common stereotype. When Gilbert (1951) and Karlins, Coffman, and Walters (1969) replicated this study, these stereotypical traits were consistently matched by participants to the same groups over a period of thirty years, thus suggesting the rigidity of stereotypes (Katz & Braly, 1933). Interestingly, however, despite being largely consistent, there were some notable changes in stereotypes for certain ethic groups over time. For example, comparing the findings of the replicated studies with those from the original research, Japanese stereotypes became more negative in 1950, possibly due to the effects of the Second World War. On the other hand, stereotypes of Jews and Blacks became more positive, showing that the contents of stereotypes could change in society over time.

After Katz and Braly (1933), stereotypes came to be strongly viewed by psychologists as an inaccurate judgement and a failure in the way people think. Moreover, since the contents of stereotypes tended to be negative, they were connected with prejudice against particular groups. The implication of this was that we should try to stop stereotyping because it might make us see people in an inaccurate and prejudiced way. As Brigham (1971) noted, "most writers agree that stereotypes are undesirable and should be eradicated" (p. 30). However, other psychologists noted that categorical judgments, such as stereotypes, can represent a useful and efficient way to help us anticipate events. For example, Brown (1965) argued that "it is a chief occupation of the human and animal mind to form categories to the end of discovering recurrence to the end of anticipating the future. We must generalize about categories and ought to generalize about categories" (p.177). He criticised the idea that generalisation on its own is problematic. Brown (1965) proposed the example of traffic lights – that is, whilst we know that each red traffic light signal is different, we wait when the red light is on because this is the rule of traffic. In other words, we have to make a categorical judgment so that we can understand and predict the traffic.

The first problem with Brown's (1965) assumption is that while we can easily distinguish whether or not a traffic light is red, we cannot judge whether or not a stereotype is accurate (Brigham, 1971). Moreover, the ways in which we measure stereotypes are debatable. There is no simple way for an individual to quickly and objectively test all of the stereotyped beliefs and categorisations that they hold. Stereotypical characteristics might be associated with a group of people and seen to be inherent to all people in the group. Brown (1965) put forth the idea that faulty stereotypes derives from 'cultural absolutism or ethnocentrism' – i.e. the belief that our worldview is correct. According to Brown (1965), viewing our cultural norms as being true rather than a specific view of our culture leads to false reasoning because we believe that a particular group possesses certain characteristics and therefore that all members of the group must possess those characteristics.

But why do individuals still hold stereotypes if they are false? One reason why individuals hold onto faulty stereotypes is that they are not aware that these are false – i.e. people assume that there must be some truth in such widely held views. Taking the proverb *There is no smoke without fire* as an example, researchers have investigated whether stereotypes might contain a "kernel of truth" (Brigham, 1971) and be based on actual facts. A second reason why individuals may hold onto faulty stereotypes is because these ideas are socially ingrained. In other words, it is important to consider the impact of culture on stereotypes. Through friends, families, and the media, individuals can be exposed to a wide consensus regarding a particular view of a social group (Deutsch & Gerard, 1955). This leads to them being more likely to see this particular view as the appropriate way to perceive the group. That is, it is quite possible that if a wide range of people we trust hold a particular view, we will follow; and the higher the level of consensus, the higher our degree of confidence that the view is "true".

2.3.2 Stereotypes Theories & Social Cognition Theory in Social Psychology

Psychologists in the 1970s began to question whether stereotypes are “faulty”. From a cognitive perspective, it was suggested that stereotypes are not “faulty” because they fall outside of normal cognition processes (e.g. Tajfel, 1969; Hamilton, 1979). Social cognition theory explains stereotypes from the perspective of information processing and memory. For example, the set of expressions used to refer to certain groups of people could form a “schema” (see Section X below). When a schema makes wrong categorisations or exaggerates the truth, this leads to the formation of stereotypes. From a memory standpoint, stereotypes are reinforced after the confirmation of common information; and information processing reinforces stereotypes when memories are stored. This process supports the formation and maintaining of stereotypes (Du, 2004).

2.3.2.1 Schema and Gender Schema Theory

One important theory we shall consider involves schema (Bartlett, 1932), which is a cognitive structure that contains and organises our knowledge about a category (Fiske & Taylor, 1991). If schemas are the ways in which we store information about categories and concepts, then stereotypes could be simply viewed as schema as well (Hamilton, 1979). Thus, stereotypes can be considered features of the normal cognition process and the organisation and retrieval of information (memory).

Gender Schema Theory (GST) talks about gender schema as the ‘cognitive structures that organize gender-related knowledge, beliefs, attitudes, and preference’ (Liben and Signorella, 1980). GST is relevant to this thesis as it contributes to a broader understanding of how and when gender stereotypes may affect girls and women on their pathway of STEM careers by emphasizing the dominant role of gender with non-STEM identity. GST also suggests that the exposure of female STEM role models in public might be salient among girls especially when they activate gender schema and process information about gender (Steinke, 2017), which is crucial to format gender identity with (or not with) STEM careers.

2.3.2.2 Social Identity Theory （SIT）

Following Social Identity Theory (SIT), Tajfel and Turner (1986) conclude that stereotypes serve as a form of categorisation, identity, and comparison. Categorisations make it easy for people to retrieve information and are made when inferring the groups to which a person belongs to. Identity relates to which groups a person identifies with. To do this, a person first establishes that they belong to a group whose members share the same stereotypes and beliefs as they do. Comparisons are made to identify differences and similarities with others in terms of social characteristics.

Using SIT, it can be said that stereotyping relates to the perception of groups. SIT assumes that self-identity and self-esteem derive from evaluating the processes that take place within social groups. In order to categorise people into certain groups, we attribute the characteristics of the group to that person. According to SIT, we have a tendency to view our own social group (in-group) more positively than other social groups (out-group) because this is how we gain our sense of self and positive social identity from the group we belong to. Thus, stereotypes might arise not only because of individual cognition but also as a motivational process of comparison to help us favour our in-group (Hinton, 2013). That is, the tendency to negatively stereotype outgroups serves to enhance our social identity (Turner & Tajfel, 1979). In other words, people tend to make positive evaluations of their own categorised in-groups and attribute positive characteristics to them. While on the other hand, make negative evaluations of out-groups, which leads to stereotypes forming. Put another way, stereotypes tend to be negative evaluations of certain out-groups.

2.3.2.3 Social Interference Theory

Following Social Interference Theory, Leyens, Yzerbyt and Schadron (1994) suggest that the formation of stereotypes is influenced by the interaction between one's growing up environments and one's current situation. Social interference theory stems from both social cognition and social identity theories to explain the reasons for stereotypes from three aspects. The first involves a shortage of knowledge, arguing that people receive limited knowledge from their growing up environments and therefore process images of certain groups of people with limited cognition of those groups, thus leading to stereotypes. The second way in which social interference theory explains stereotypes is by highlighting the way humans simplify information. It is efficient for people to evaluate individuals and objects using existing schema which categorise groups of individuals and objects with certain similar features. This process helps us organise and explain phenomena and people rapidly. Thus, stereotypes are viewed as the results of a cognitive process of simplifying information about life. The third aspect proposed is that stereotypes might result from improper evaluations about the environments in which individuals live.

2.3.3 Sexism and Gender Attitudes

2.3.3.1 Old-fashioned Sexism to Modern Sexism

Sexism as a concept developed in the US and is defined as "negative attitudes and behaviour toward someone on the basis of their gender" (Nelson, 2006, p. 199). In most societies, women have historically experienced gender-based discrimination. For instance, there has been a significant period of time where they had no political rights and were barred from university studies. Although there were always exceptional women who managed to gain access, these women were usually from 'elite' families. World War II paved the way towards achieving equal job opportunities for women as they were needed to replace men who had gone to war. For instance, they were employed to do work which men used to do in factories. As explicit access blocks began to diminish, gender inequality began to manifest in more subtle forms (Benokraitis, 1997).

According to Swim, Aikin, Hall and Hunter (1995), historical and traditional 'old-fashioned sexism', which constituted institutionalised discrimination and overt harassment, began to transform into more modern (subtle) forms of sexism, as had been seen with racism following the civil rights movement. Swim et al. (1995) defined old-fashioned sexism as the negative endorsement of women and differential discriminatory treatment of women compared with men; in contrast to modern sexism, which is “indicated by the denial of discrimination against women, a hostility toward equality for women, and non-support of programs and legislation designed to help women” (cited in Nelson 2006, p. 224).

Swim et al. (1995) indicated that old-fashioned and modern sexism are distinct and correlated concepts by measurements[3]. The key difference between old-fashioned and modern sexism is that the latter is expressed in a veiled way that is more socially acceptable; for instance, by rebelling against “politically correct” positions or affirmative action programmes. On the other hand, old-fashioned sexism is expressed explicitly through statements like “women are generally not as smart as men” (Swim, et al., 1995, p. 212). Accordingly, individuals may find modern sexist attitudes less offensive and may thus remain unchallenged (Barreto and Ellemers, 2005). Nevertheless, both old-fashioned and modern sexism result in discriminatory behaviours against women.

2.3.3.2 Neosexism

Around the same time as Swim et al. (1995), Tougas, Brown, Beaton, and Joly (1995) defined the term “neosexism” as the “manifestation of a conflict between egalitarian values and residual negative feelings toward women” (p. 843). Neosexists tend to defend the women equity and believe the society is male-dominated by resisting the policies and denying the status of women in discrimination situation (Tougas et al., 1995). A test was run to indicate this idea, suggesting that women were gaining more power positions, with increasing treat feelings from women's self-report (Beaton, Tougas, & Joly, 1996), which verified the idea of neosexist beliefs: the more equality women get, the less likely polices support by men in a male-dominated society (Beaton et al., 1996). Scales for neosexism and modern sexism are relatively

[3] The Modern Sexism Scale was adapted from many items in McConahay’s (1986) modern-racism scale (MRS). All relevant scales and measurements in this section will be discussed in Chapter Five.

related but can also be distinguished (Campbell, Schellenberg, & Senn,1997). Neosexism scales focus on attitudes related to policies helping women's status (Tougas et al., 1995), which modern sexism scales could also predict. However, modern sexism scales also concentrate on the denial of continued discrimination against women (Swim, et al, 1995).

2.3.3.3 Ambivalent Sexism: Benevolent Sexism and Hostile Sexism

Shifts in societal sexism led to multiple emerging theories of modern sexism. One of the most popular measurements of more subtle modern measures is that of ambivalent sexism (Glick & Fiske, 1996). Glick and Fiske (1996) suggest that men who hold ambivalent sexism have 'positive' or 'benevolent' attitudes toward (some) women, but at the same time, hold more negative traditional, or even 'hostile' attitudes toward women, such as believing that women are less intelligent and less competent than men. Although benevolent sexism and hostile sexism may seem different, they are based on the same traditional beliefs of the inferiority of women to men in a male-dominated society. Benevolent sexism tend to 'respect' and protect women who take domestic roles, such as mothers and wives; but hold hostile attitudes toward women who eschew traditional gender roles, such as those in powerful positions. Benevolent sexism can change to hostile sexism when women resist the traditional domestic society roles (Viki & Abrams, 2002). Men holding such stereotyped views of women are more likely to have hostile attitudes and beliefs, such as tolerance of wife abuse (Glick, Sakalli-Ugurlu, Ferreira, & de Souza, 2002), and blaming the victim in an acquaintance rape scenario (Abrams, Viki, Masser, & Bohner, 2003).

According to Eagly & Mladinic (1989), compared with men lower in sexism, those higher in ambivalent sexism show stronger negative reactions towards some women (e.g. 'sluts'), while having stronger positive affective responses toward other women (e.g. 'saints'). Studies conducted by Glick, Diebold, Bailey-Werner and Zhu (1997) explored this conflicting ambivalence. The results firstly confirmed the manipulation of hostile sexism and benevolent sexism by Glick and Fiske (1996), whether the statue of women fit into traditional roles. Then the ambivalent sexists tend to category women into groups either favour or un favour to avoid the conflict (Glick, et al., 1997). If unable to simply category women into those favour or not groups, ambivalent sexists would evaluate women by many different dimensions, therefore, explain the different attitudes towards women and the conflict of ambivalent sexists. Interestingly, another survey explored women react to these sexisms, that women didn't believe that hostile sexism and benevolent sexism could be the same person, moreover, women most favour into non-sexists, the least favour hostile sexists (Kilianski & Rudman, 1998).

2.4 Gender and STEM

In the 1980s, social role theory emerged to provide a better understanding of gender similarities and differences in social behaviours (Eagly, 1987; 1997). The theory was based on the fact that women were paid less, tended to do more domestic work than men (job segregation), and worked less in highly paid positions worldwide (e.g. Reskin & Padavic, 1994).

2.4.1 Gender Socialisation and Gender Roles

From a social psychological aspect, gender is learned by socialisation – i.e., the proceess by which individuals learn their gender-relevant identities and behaviours to fit into the social roles. In other words, gender socialisation explains gender differences and gendered behaviours (Carter, 2014) such as gender differences in subject choice and career roles.

2.4.1.1 Gender Socialisation

Gender socialisation is the earliest or basic form of socialisation newborn babies encounter. The basic idea of gender socialisation theory is applied to socialisation in general in an attempt to explain how general self-identity develops, and how gender role expectations and gender identity interact with social environments (Stockard, 2006). Children typically first learn gender roles from their families (Freeman, 2007; Halim & Ruble, 2010). Socialisation occurs through parents/caregivers modelling their relationship and career choices (Preves & Mortimer, 2013) and through how children are treated based on their gender (e.g. Peterson & Hann, 1999). Young boys and girls internalise and assimilate the standards of gender identity via interactions, settings, and comparisons between themselves with others (Burke, 1989; 1991; Burke & Stets, 2009). These interactions will direct children as to what roles and behaviours are suitable for a male or female. During the process of gender socialisation, certain gender features and cognitions are being formatted – i.e. children establish a basic standard for their gender identity, which also include gender role expectations.

2.4.1.2 Gender Identity and Gender Role Expectation

According to Bandura's social learning theory (1977), children learn new behaviours not only from their direct experiences (e.g. observation), but also through external and internal reinforcements. External reinforcements come from the environment, for example, through modelling examples, which is how most behaviours are learnt 'either deliberately or inadvertently' (Bandura, 1977, p. 5). For children's learning of gender beliefs and behaviours, the key influencing roles are their parents, peers, and teachers (Freeman, 2007). Adler, Kless and Adler (1992) explain the gender socialisation process in relation to peer subculture, as children adapt their behaviours to suit their social gender roles among other girls and boys in elementary schools.

Social identities also represent certain social groups (Reid & Deaux, 1996). This means that once children have internalised their gender roles, not only do they act like certain genders, they also need to meet the expectations of that particular gender identity. For instance, Wood and Eagly (2015) suggest that people endow gender identity with certain gender attributes: female gender identities with the feminine (e.g. caring and passive), and male gender identities with the masculine (e.g. aggressive and competitive). With these gender identities, women are usually expected to be carers, rather than leaders (e.g. Green, Renfrew & Curtis, 2000; Eagly & Karau, 2002), while men are more likely to be considered leaders than carers (e.g. Arber & Gilbert, 1989; Koenig, Eagly, Mitchell & Ristikari, 2011). These expectations also manifest themselves as particular characteristics considered necessary for leadership. For example, women needing to dress in a "masculine" way to take on leadership roles (Phelan & Rudman, 2010). However, culture influences the cues for what the expectations are for members of certain social groups (Stets, 2006). Thus, across cultures, there could be various gender expectations and stereotypical gendered beliefs and behaviours that emerge during the process of gender socialisation.

Social learning theory (Bandura, 1977) was later expanded into social cognitive learning theory (Bandura, 2002), incorporating cognition in social learning in order to take a more holistic and less passive view of socialisation. When it comes to children's development and gender socialisation, this theory contributes to the understanding of gender differences in behaviours resulting from children's cognitive development (Martin, Ruble & Szkrybalo, 2002). Some researchers suggest that infants might be able to realise gender differences in their first months by observing the different gender clothes worn by people (Fagot, Rodgers, & Leinbach, 2012). Children find gender differences automatically and are eager to apply this new knowledge to match objects that lead to increased knowledge of gender stereotype behaviours (Maccoby & Jacklin, 1975). However, part of the development of gender cognition, gender stereotypic beliefs might not be necessary (Maccoby, 1998), which means that certain gender stereotypes as schema combined with gender socialisations.

2.4.1.3 Cognitive Development Theory

According to social learning theory (Bandura, 1977a), gender roles are only learned passively, via a one-way learning process from culture. However, this is not a convincing way of understanding gender socialisation (Corsaro & Eder, 1990). Thus, the theory was expanded in order to take a more holistic view by incorporating cognition in social learning. Thus was born social cognitive learning theory (Bandura, 2002). When it comes to children's development and gender socialisation, this theory contributes to the understanding of gender differences in behaviours resulting from children's cognitive development (Martin, Ruble & Szkrybalo, 2002). Some researchers suggest that infants might be able to realise gender differences in their first months by observing the different gender clothes worn by people (Fago, Rodgers, & Leinbach, 2012). Children find gender differences automatically and are eager to apply this new knowledge to match objects that lead to increased knowledge of gender stereotype behaviours (Maccoby & Jacklin, 1975). However, part of the development of gender cognition, gender stereotypic beliefs might not be necessary (Maccoby, 1998), which means that certain gender stereotypes as schema combined with gender socialisations.

2.4.2 Gender Stereotypes

Gender stereotypes refer to a set of gendered attitudes and beliefs held by people regarding gender differences, attributes and characteristics associated with men and women or boys and girls (He, 2006; Maccoby, 2002). They reflect social irrationality on gender reality and make these irrationalities rational and immobilised (He, 2006). Gender stereotypes can affect cognition, attribution, motivation, and behaviour in relation to career choices (Du, 2004).

It is widely believed among researchers that gender stereotyping begins at birth, from infants' first social contact with their parents. Early researchers suggested that the way parents treat their children in accordance with certain gender stereotypes could represent the first things they learn about their gender (Rubin, Provenzano, & Luria, 1974). For example, some studies suggest that 26-month-old children are aware of adults' gender from their appearance (e.g., clothes, physical appearance). Even during parent-child conversation, parents tend to talk more about action activities with boys and about physical appearance with girls (Cristofaro & Tamis-LeMonda, 2008). However, subsequent researchers have argued that this effect might not be reliable or consistent (Stern & Karraker, 1989) and might take place over time (Karraker, Vogel, & Lake, 1995). That is, children might engage in gender socialisation and show an awareness of gender stereotypes at birth but they may then develop different gender-related factors as they grow.

Parents' beliefs about gender might also impact children's gender socialisation, especially those related to gender stereotypes (Fagot, Leinbach, & O'Boyle, 1992; Hoffman & Kloska, 1995; McHale, Crouter, & Tucker, 1999). For instance, parents' gender stereotype beliefs regarding what gender roles should be taken in society could be reflected in children's gender schema regarding occupational gender roles (Tenenbaum & Leaper, 2002) and could affect children's career choices. Additionally, children tend to play with gendered toys (e.g. cars for boys, dolls for girls) and play with same-sex friends (Weisner & Wilson-Mitchell, 1990). According to Ruble, Martin and Berenbaum (2007), children can show an awareness of gender stereotypes regarding toys at around 31 or 32 months. Additionally, Miller, Lurye, Zosuls and Ruble (2009) also found that children associated descriptions of boys and girls with specific gender-stereotyped themes (e.g. girls were associated with appearance and boys with hitting).

Overall, the ways in which parents have an impact on gender stereotyping processes are mixed and complicated. The theories and research reviewed indicate that family and society have gendered role expectations of boys and girls, who react to different gendered behaviours and assimilate and internalise their gendered beliefs. In certain situations, gender stereotypes can lead to gendered beliefs and certain gendered behaviours. When picking up their gender roles from the various sources that their families and society offer, girls and boys assimilate their gender roles and picture what they will look like in the future. Gender stereotypes can also affect the process by which boys and girls learn their gender roles in social contexts. The beginning of gender socialisation is where gender stereotypes start.

2.4.2.1 Stereotype threat

Steel and Aronson (1995) initially proposed the notion of stereotype threat. Stereotype threat is experienced when one feels anxiety and a stereotype belief affects performance. Relevant to gender and STEM, it is believed that stereotype threat affects girls' math self-efficacy (Steele & Aronson, 1995; Aronson & Steele, 2005) as the lack of belief in their abilities to successfully complete mathematical tasks (Hackett & Betz, 1989; Pajares & Miller, 1994). Good, Aronson and Harder (2008) found that when the stereotype threat has gone, women tend to have a higher level of maths performance. This was later corroborated by Johnson, Bernard-Bark, Saxon, and Johnson (2012) using multiple gender-maths stereotypes conditions.

Besides negatively affecting women's maths performances and self-identity, the threat can lead to women underperforming linguistically and using tentative language (McGlone & Pfeister, 2015) or increase women's inflexible perseverance (Carr & Steele, 2009). Gender stereotype threat might also affect women's self-identity negatively as stereotypes affect their self-perceptions (Ahlqvist, London & Rosenthal, 2013). Hoyt and Murphy (2016) further suggest that gender stereotype threat might affect women's motivation to engage in leadership positions. In brief, the consequences of gender stereotype threat can be diverse. On the whole, women under gender stereotype threat might fail to perform well in many tasks.

2.4.3 Implicit social cognition: Implicit stereotypes and explicit stereotypes

As stereotypes contain a wide range of definitions, little consideration is made as to whether stereotypes are conscious or unconscious. However, social information processing does not only relate to conscious social behaviours but could also relate to implicit information processing. That is, past experiences are not traceable by individuals who cannot self-report or engage in introspection, which is implicit social cognition. Greenwald and Banaji (1995) applied implicit social cognition theory to develop methods of measuring implicit attitudes, implicit self-esteem, and implicit stereotypes.

Implicit and explicit stereotypes offer us different ways of understanding the stereotypes from social cognitional perspectives. More recently, implicit and explicit stereotypes have been defined by the activation and application of stereotypes, that is, implicit stereotypes are associations for stereotypes that could be activated automatically; explicit stereotypes are associations for stereotypes that could be controlled by individuals (Arendt, 2013; Arendt, Marquart & Matthes, 2015).

Greenwald and Banaji define implicit stereotypes as "introspectively identified (or inaccurately identified) traces of experience that mediate attributions of qualities to members of a social category" (1995, p.14). This view is based on an implicit social cognition model: 'implicit stereotypes are the behavioural outcomes of associative processes, whereas explicit stereotypes represent the behavioural outcomes of propositional processes' (Arendt, 2013, p. 832). However, the various definitions of the different kinds of stereotype might share some similar words. Explicit might be described as awareness, self-conscious and self-reported. Implicit might be referred to as automatic and unconscious. There is some debate as to whether unconscious attitudes break the close chain of implicit and unconscious. Gawronski, Hofmann and Christopher (2006) believe there are still some unconscious attitudes that cannot be accessed by implicit measures for individuals, as awareness of attitudes is not the only indirect measure (e.g., self-report) to which they have access. However, we could address the role of awareness of prejudice control. For this thesis, I conclude that people to some extent are aware of their implicit prejudice associations because they can adjust their behaviours to “correct” them (e.g., Wegener & Pett, 1995). Thus, with the proof of a “correct” process, implicit racial prejudice could be activated automatically. I believe that people might have some awareness of implicit gender stereotypes as well as self-control (Fazio & Olson, 2003). The discussion of the role of awareness in implicit stereotypes only helps our understandings and interpretations of the cognitive processes of implicit stereotypes. It would not interfere with the measures used to detect the implicit stereotypes.

2.4.4 Definition of STEM

There is no universal definition of STEM subjects. STEM is not just the abbreviation described in Chapter One. From a workforce perspective, it encompasses more than simply “the application of science, technology, engineering or mathematics knowledge and skills; and/or requires an appropriate qualification in a STEM subject; and /or is located in a particular industry or sector, such as pharmaceuticals, construction or aerospace” (Department for Business, Energy & Industry Strategy, Department for Education, the Comptroller and Auditor General, National Audit Office, 2018, p. 13). It should be noted that some of the jobs in STEM fields do not require STEM skills (e.g. HR). From an educational perspective, STEM refers to either a single subject or a combination of subjects, which is the main discussion area in this research. Furthermore, in social and educational psychological research, STEM always relates to maths-intensive subjects, as mathematical ability is one of the points in which there is suggested gender disparity in cognitive abilities (e.g. Watt, Hyde, Petersen, Morris, Rozek & Harackiewicz, 2017).

In the context of this thesis, it is worth noting that STEM might have different definitions and names in the UK and China with their specific levels and educational systems. In the UK educational system, in A Levels (national exams taken at the age of 18), STEM is defined as mathematics, further mathematics, biology, chemistry, physics, ICT, computing, other science and design and technology (D&T). Moreover, pupils are free to choose certain subjects in order to meet the criteria for studying certain majors at college and university (e.g. they normally need to pass 3 or 4 subjects to get into university). In China[4], the requirements are slightly different in order to get into college or university. It is compulsory to choose from science and humanities subjects in the second year of high school, which then leads to choosing either science and engineering or humanities and arts. The science and engineering route here mean the same as STEM fields.

Essentially, the definitions of STEM in the two countries share the same content, especially at the university level. All of the participants of this research are university students and researchers and thus have the same understanding of STEM content. Since it might be confusing when the participants share their experiences of why they chose STEM subjects before university, all subjects, majors and contents within STEM fields will be referred to as STEM subjects, STEM majors and STEM fields; while all others will be referred to as non-STEM subjects, non-STEM majors and non-STEM fields throughout this thesis.

2.4.5 Women's underrepresentation in STEM: Research on gender differences in STEM fields

This section will look at how psychologists explore the phenomenon of women's underrepresentation from the perspectives of women themselves and the environmental impacts, especially the interpretations of gender differences relating to women's mathematical achievements and interests, and expectations from their parents and teachers. Lastly, the glass ceiling and leaky pipeline will be discussed as possible reasons why women are not represented in high-level positions.

[4] In Chinese high schools, in the first of their two years of high school, students study all of the subjects on the curriculum (Chinese, English, mathematics, geography, history, politics, physics, chemistry and biology and ICT), after which they specialise in their second year of high school, choosing between humanities - which includes Chinese, English, mathematics, geography, history and politics; and science - which includes Chinese, English, mathematics, physics, chemistry and biology. Normally, mathematics in the science stream is more advanced than mathematics in the humanities stream.

2.4.5.1 Gender differences of math ability and achievements in math-intensive fields

As mentioned in 2.4.4, gender differences in terms of maths performance and improvement might be the result of stereotype threat conditions. Moreover, researchers have explored women's underrepresentation in STEM fields in terms of women's abilities. Women are underrepresented in many fields, especially maths-intensive ones. Mathematical skills could be considered essential for many disciplines, especially in STEM. However, there are many other fields that also involve a great deal of mathematical ability in which women are well represented, such as accounting and biology. Mathematics scores are widely used to indicate performance and measure gender differences. Meta-analysis across 100 studies shows no gender differences observed between boys and girls in elementary school, but a gap emerges in high school (Cohen, 1988) and college (Hyde, Fennema, & Lamon, 1990), with boys moving ahead. This trend becomes even more marked when focusing on specific groups, such as gifted children (Hyde, Fennema, & Lamon, 1990).

Researchers have questioned whether these gender differences in mathematics scores are caused by differences in boys' and girls' cognitive abilities or are due to sample selections (Hyde et al., 1990) or something else altogether. For example, with gender-maths stereotypes priming (i.e. showing girls gender stereotypes related to maths before testing), girls tend to perform worse at maths than boys (Cohen, 1988). Therefore, the variation of experimental settings might lead to boys performing better in maths and gender stereotypes might have an impact on girls' maths achievements as well. However, research does suggest that gender differences in maths ability could vary with different cognitive abilities at different age stages. In the early period, from kindergarten to primary school, boys tend to perform better than girls at maths (Lindberg, Hyde, Petersen & Linn, 2010; Robinson & Lubienski, 2011). However, girls tend to show better verbal abilities than boys throughout childhood (Robinson and Lubienski, 2011). In terms of spatial orientation, some studies suggest that boys are better at this task from infancy and preschool (Moore & Johnson, 2008; Quinn & Liben, 2008); while others argue no differences are found in this period (Möhring & Frick, 2013; Frick & Wang, 2014). Thus, gender differences in terms of spatial orientation skills are somewhat uncertain (Miller & Halpern, 2013).

Can maths achievements and maths-related cognitive abilities (e.g., spatial memory) partially explain the gender differences seen in terms of mathematical performance? Some researchers were not able to prove this statistically, because no significant gender differences were shown in the subjects' maths scores (Ceci & Williams, 2010). For spatial tasks, some researchers argue that boys are socially primed for performing spatial tasks (e.g., Rodán, Gimeno, Elosúa, Montoro, & Contreras, 2019). Moreover, Lange-Küttner (2010) suggests that spatial memory could be improved by training (i.e., drawing) among boys (age 10) and girls (age 8). However, studies have shown that girls and boys might favour different cognitive activities: girls tend to have stronger verbal skills (Hyde, Lindberg, Linn, Ellis, & Williams, 2008; Park, Lubinski, & Benbow, 2008; Ceci, Ginther, Kahn & Williams, 2014). Thus, no strong gender differences in maths achievements and maths-related cognitive abilities were demonstrated between boys and girls. Researchers have tried to explore what happens later to explain the gender differences in maths-intensive fields, such as STEM fields. Even if there are no gender differences shown in mathematical achievements, we cannot ignore the priming impact on girls and boys. Indeed, many researchers have found that gender-maths stereotypes could negatively impact girls, which might affect their maths-related interests and career choices (Gunderson, Ramirez, Levine, & Beilock, 2012).

2.4.5.2 Cognitive ability related to STEM career preferences and accomplishments

Although gender differences in mathematical achievement and maths-related cognitive abilities are controversial, research suggests that relative cognitive strength could explain career choices, especially for STEM fields (Valla & Ceci, 2014). Evidence shows that gifted and talented children tend to have specific cognitive abilities in comparison to their other abilities (Lohman, Gambrell, & Lakin, 2008). If so, these specific abilities could affect their career choices. To be more specific, among people gifted in mathematics, those who are better at maths and verbal skills are more likely to embark in careers in STEM fields (Wang & Degol, 2013). The reason might be that those who have good maths and verbal skills are more likely to pursue a job that is not too challenging and seek a position that is easy to keep (Andrew, 2008). However, women in gifted groups still tend to choose careers in non-STEM fields rather than in STEM fields. The fact that even if they are good at maths but do not choose maths-related careers might be because they pursue different aims for their careers – e.g. women tend to have higher aspirations and accomplishments for their careers (Park, Lubienski & Benbow, 2007).

This might help us to understand why fewer women with maths aptitude are in STEM fields. As women are more capable in both verbal skills (Park et al., 2008; Wang, Eccles, & Kenny, 2013) and maths skills, they might find much more flexibility in terms of career choice in non-STEM disciplines (Ceci & Williams, 2010; Wang, 2010). The key is women's verbal skills, as they all fall into the high maths aptitude group. With stronger verbal skills, women tend to choose non-STEM fields, or leave STEM subjects and switch to non-STEM subjects. It is possible that they are equally talented in maths and verbal skills, in which case they might have equal ambitions for both of those careers (Ming & Degol, 2013). Another reason might be that compared with maths-intensive fields, non-STEM fields might be considered more practical and applied (Ming & Degol, 2017). Again, cognitive strength might not be the factor driving women away from maths-intensive fields (Ming & Degol, 2017) since even women talented in maths are leaving STEM fields. This might help us understand that in this condition, given two relatively even choices for a career, other factors become much more influential when women make their decisions.

2.4.5.3 Impacts of teachers' expectations and stereotypes on students

Teachers' expectations might affect students' self-expectations and performances, especially in relation to completed beliefs (Metheny, McWhirter, & O'Neil, 2008). These influences tend to affect female students with negative gender-stereotyped beliefs. Teachers tend to have different expectations of boys and girls, showing implicit gender-science stereotypes to girls (Chalabaev, Sarrazin, Trouilloud, & Jussim, 2009); that is, teachers hold the implicit stereotype that maths is not for girls (Fennema, Peterson, Carpenter & Lubinski, 1990; Li, 1999). Moreover, if boys are successful in maths and science, teachers attribute that to boys' abilities. Instead, if girls are doing well in maths and science, teachers tend to give credit to girls' efforts, as opposed to their abilities (Fennema et al., 1990; Keller, 2001; Tiedemann, 2002). And this still happens continuously with high-achieving women (Fenema et al., 1990). Additionally, some other factors might mediate students' maths achievements when it comes to students' gender and teachers' expectations, with both underestimations and overestimations. When McKown and Weinstein (2002) added ethnicity as a variable, they found that among fifth-grade children, African American students were found to be more vulnerable than Caucasians when they all received underestimated expectations from teachers. Moreover, girls were more vulnerable than boys when their maths ability was underestimated. Therefore, gender-maths stereotypic beliefs of maths abilities might affect students' maths achievements.

However, some factors could have a positive impact on female students when interacting with teachers and students (Jussim & Harber, 2005; Hattie, 2012). For instance, teachers' pedagogical goals might be essential to help students, as they could manipulate the students' motivation patterns (Eccles & Roeser, 2011). Despite facing lower expectations, students might be supported by teachers' instructions (Eccles, 2009). However, research on these "positive" impacts and interactions is limited. This really varies with the interaction between students and teachers, and the beliefs that teachers have. For example, when females are exposed to a female role model in STEM fields, this enhances the females' self-concepts regarding STEM subjects, which leads to improvements in STEM courses (Herrmann, Adelman, Bodford, Graudejus, Okun & Kwan, 2016).

As mentioned previously, stereotypes might not be recognised consciously – i.e. people might have implicit gender stereotypes without awareness. Teachers may hold implicit gender stereotypes, which leads to stereotyped expectations of students. These affect interaction between teachers and students (Jussim, Eccles, & Madon, 1996). Given these implicit gender stereotypes, teachers cannot justify their different expectations of different students' performances and achievements. The mediation of how this negatively impacts students varies. Teachers are more likely to associate boys with higher maths abilities and be biased against girls' maths abilities (e.g., Turner & Patrick, 2004; Jussim & Harber, 2005; Hattie, 2012). Thus, implicit stereotypes could also affect teachers' expectations without their awareness, and certain types of implicit stereotypes are more likely to be triggered, such as gender-science stereotypes.

2.4.5.4 *Role models for aspirations and interventions*

As proposed by the social learning theories in 2.4.1.3, children learn social behaviours through modelling (Bandura, 1977b). Parents and teachers not only impact children's and students' gender expectations and stereotyping beliefs in STEM majors, they can also be role models. Role models can be peers, teachers and anyone in STEM fields. They can influence girls' career choices and aspirations for STEM careers (Scherer, Adams, Carley & Wiebe, 1989; Morgen, Ryan & Peters, 2015). Role models are always considered to have a positive impact in terms of many aspects because they are the potential examples of what is attainable. Women's performances could improve with more exposure to role models (Latane, 1981) in areas such as academic performance and persistence in STEM courses (Herrmann et al., 2016). Research indicates that same gender (female) successful role model exposure has a positive effect; that is, it not only improves women's performance but also reduces the negative impact of gender stereotypes (McIntyre, Paulson, Taylor, Morin & Lord, 2010).

Moreover, if role models are professionals and experts in those fields, they can help girls form a closer self-concept with those fields. For instance, exposure to professional female role models could increase female students' sense of belonging to STEM fields, and enhance their connection with STEM fields, especially when the role models and female students share a similar biographic background (Shin, Levy & London, 2016). Thus, it can be argued that role models form an external defence against gender-STEM stereotypes (Kapitanoff & Pandey, 2017), and female (expert) role models in STEM fields might have a positive impact on girls' career choices and their performances in STEM fields.

However, it should be noted that role models might not always have a positive influence as they might cause negative comparisons in terms of achievements and interfere with the final results (Collins, 1996). Lockwood and Kunda (1999) suggest that if students are primed with the “natural” state of their selves instead of their “ideal or better” self “in the future” when comparisons are made, they will make positive connections with role models’ accomplishments and their own perceived abilities. So, if girls take a role model that is not “perfect” but who has overcome barriers and challenges, such a “real” person like themselves might prevent the negative impacts of role models (e.g. Lin-Siegler, Ahn, Chen, Fang, & Luna-Lucero, 2016). In other words, role models have both positive and negative impacts, and this might impact implicitly their attitudes towards STEM fields (Stout, Dasgupta, Hunsinger & McManus, 2011) and implicitly change their self-concept and their perceived compatibility with STEM (Shin, Levy & London, 2016). Female experts in STEM fields might also affect their career choices, and prompt them to either commit to STEM fields or leave them. The few female role models in society and the unexpectedly hard path followed by successful women in the fields might discourage women from getting involved at all (Smith, Lewis, Hawthorne & Hodges, 2013). More support for the impact of role models on girls can be found in girls’ maths classes based on their academic motivations. For example, it has been found that girls achieve better performances in maths class if they are primed with examples of female scientists (Eccles, 2007; Else-Quest, Hyde, & Mertz, 2009). When girls learn of the underappreciation of women in maths-intensive fields, they tend to leave maths classes as shown by many cross-national studies (e.g. Else-Quest et al., 2010; Picho, Rodriguez, & Finnie, 2013).

2.4.5.5 Belonging interventions

Underrepresentation of certain groups of people caused by negative gender or racial stereotypes regarding their maths and intellectual abilities leads to the undervaluing and disrespecting of these groups (e.g. minority groups in school) and undermines their sense of belonging, as well as their motivation and performances (Walton & Carr, 2012). Even if social interventions are made to increase their sense of belonging to improve academic performances, the positive impacts will weaken over time (Walton & Cohen, 2007; 2011). Walton (2014) refers to such measures as “wise interventions” and indicates that precise interventions (e.g. critical recursive processes) and strategies could bring about consistent and lasting improvements.

In recent research, such interventions have been applied among racial minority women who are underrepresented in STEM fields. The aim was to boost the efficacy of these interventions with precise strategies that correspond to each psychological process or theory and improve the equality of women in STEM education (Casad, Petzel & Ingalls, 2018). Thus, social belonging could defend people from negative stereotyping effects as it could provide strength. However, this belonging could weaken over time if precise interventions and strategies are not in place. These results support earlier findings discussed in relation to reducing sexism. In Jones and Jacklin's (1988) study of whether sexist beliefs could be reduced with introduction courses for women and men, they found positive results of the interventions' efficacy. Later O'Neil (1996) also showed that men's sexist beliefs become more egalitarian after theory treatment. However, those results were not permanent and required consistent interventions (Nelson, 2006). To reduce sexism and combat the negative impacts of gender stereotypes, changes are needed at multiple levels: sexist thoughts, attitudes and behaviours.

2.4.5.6 Own interests in STEM careers

Recent studies taking a goal congruity perspective suggest that women tend to overlook careers in STEM fields and choose primarily communal goals, rather than the agentic goals of STEM careers (Diekman, Clark, Johnston, Brown & Steinberg, 2011). One possible reason for this is that women are more likely to help others and perform tasks that are beneficial to society (Freund, Weiss & Wiese, 2013). For instance, there is research suggesting that women are more likely to do caring jobs because of their biological and sociocultural features (Wang & Degol, 2017). These jobs are often labelled as "women's work", which is also a stereotype – e.g. women tend to work with people and men tend to work with things (Su, Rounds & Armstrong, 2009).

When students make career decisions, their interests might be essential. Maltese and Tai (2011) found that the growing interest in science and maths are the main reason why more and more students are choosing STEM in high school. The timing for establishing career preferences might be in late adolescence (Correll, 2001), which is the time when students are exposed to courses in science and the humanities in the educational system and are preparing to choose between humanities and science in high school and college. Thus, maths and science interests might contribute to women's career preferences. However, women's career preferences might not be the result of their skills, but of other factors which need to be taken into consideration, such as their career accomplishments and aspirations (Park et al., 2007).

2.4.5.7 "Glass ceilings" and "Leaky pipeline"

An important consideration regarding women's underrepresentation in STEM careers, and particularly more senior career pathways, is summarised in terms of "glass ceilings" - defined as 'those artificial barriers based on attitudinal or organisational bias that prevent qualified individuals from advancing in their organisation into upper management positions' (US Department of Labour, 2020). Research indicates that when women are pursuing high-level educations or careers, they are faced with difficulties that other same qualified male colleagues do not have. Therefore, although they are qualified, they cannot get the top (management) positions due to a number of unseen barriers. For example, despite women showing no significant differences in leadership styles from men (Eagly & Johnson, 1990), they might not have as robust a social network as men at higher levels (Taylor, 2010). Furthermore, women still suffer from expectations stemming from stereotype threats in STEM careers, which may relate to their perceived leadership skills (Hoyt & Murphy, 2016). For instance, women leaders encounter more stereotype threats because they tend to assimilate ideas when doing "masculine jobs" (e.g. wear male clothes when working in STEM fields). Thus, women suffer a double stereotype threat in that they are not doing female jobs and do not appear as women (Heilman, 2001; Eagly, Gartzia, & Carli, 2014). Another point argued is that even when women are offered promotion, they tend to reject it because of the high post-promotion risks when occupying male-dominated positions (e.g., Heilman, 2001; Eagly & Karau, 2002).

An alternative analogy for women's underrepresentation in STEM careers, or in senior academic positions, is the so-called "leaky pipeline", which means that women might quit studying STEM subjects or pursuing STEM careers. There are three ways in which this manifests itself: 1) unequal job pay and job segregation, 2) female executive and elite (leader) underrepresentation, 3) issues with family and work balance. These social issues have been found ever since women entered the workforce doing jobs that men used to do. As people associate women with certain characteristics (e.g. related to nature), certain types of jobs are considered "female work" (e.g., Eagly & Mladinic, 1989). This is the case in Western countries, like the UK, but also in China which has a very apparent segregation of occupations and academic subjects by gender. For example, women are more likely to be considered for "caring" roles in society. Women tend to be occupied in normal school (for teachers) and nursing areas, which fits the stereotype of their "housewife roles" and of so-called "female subjects". These concepts frequently emerge in Chinese research which highlights how women are viewed as needing to be good wives and good mothers (Li, 2002). This leads to unequal treatment (e.g. unequal pay) and job segregation, which are still severe problems (e.g. EHRC report). In contrast, men are widely found in STEM fields, which have much more social prestige and higher incomes. These might be strong reasons why women choose STEM fields as those types of job are generally well paid (Mohan, 2018).

3. CHAPTER THREE: CROSS-CULTURE IN FEMINISM AND STEM

This chapter will broadly discuss the concept of culture, (Section 3.1), cross-cultural theories and research in psychology (Section 3.2). Followed by a brief history of feminism in the UK and China (Section 3.3) and concluding with gender-STEM research in these two nations (Section 3.4). The chapter specifically focuses on how gender emerges within cultures, particularly exploring this concept in the cross-cultural contexts of the UK and China.

3.1 Defining Culture

Culture is defined in multiple ways by many scientists from different fields. One definition was first published in 1952 when the anthropologists Kroeber and Kluckhohn (1952) argued for universal categories of culture:

> In principle ... there is a generalized framework that underlies the more apparent and striking facts of cultural relativity. All cultures constitute so many somewhat distinct answers to essentially the same questions posed by human biology and by the generalities of the human situation. ... Every society's patterns for living must provide approved and sanctioned ways for dealing with such universal circumstances a the existence of two sexes; the helplessness of infants; the need for satisfaction of the elementary biological requirements such as food, warmth, and sex; the presence of individuals of different ages and of differing physical and other capacities (pp. 317-18).

Psychologists also tried to define culture as:

> Shared attitudes, beliefs, categorizations, expectations, norms, roles, self-definitions, values, and other such elements of subjective culture found among individuals whose interactions were facilitated by shared language, historical period, and geographic region (Triandis, 1972, p. 3).

Based on these definitions, it can be said that the primary difference between anthropological and psychological definitions of culture might be whether culture focuses on "ideals" or practical "materials". This ideal-material dichotomy discussion regarding culture was brought up by Cole and Packer (2011) as they proposed culture as "a dynamically changing environment that is transformed by the artifacts created by prior generations, extending back to the beginning of the species" (p. 135) That is, an artifact belonging to the material world modified to fit in human's ideas and actions to adapt the environment over time (Cole, 1996) means the changing process of an artifact is both material and ideal at the same time. D'Andrade (1986) supported this by pointing out "material culture - tables and chairs, building and cited - is the reification of human ideas in a solid medium" (p. 22). Therefore, artifacts could be used as medium to help human to incorporate with the physical world in various cultures. Later, psychologists moved forward with more empirical research on the link between culture and cognition:

> Human thought is basically both social and public - that its natural habitat is the house yard, the marketplace, and the town square. Thinking consists not of 'happenings in the head' (though happenings there and elsewhere are necessary for it to occur) but of trafficking in…significant symbols - words for the most part but also gestures, drawings, musical sounds, mechanical devices like clocks (

, 1973, p. 45).

The cultural ‘artifacts’ conception extends from material objects to the secondary artifacts argued by Watofsky (1973) to focus on preserving and transmitting ‘social inheritances’, such as through recipes, beliefs, norms, conventions, and other non-tangible cultural capital we may pass on from generation to generation. This conception shares similarities to the thought units of ‘schemata’ in psychology (see also Section 2.3.2), which means a mental structure contains a set of conceptions to help the cognitive process (e.g. thinking quickly) (see also Section X on stereotypes and gender schema). Among psychologists, Bartletts’ (1932) described schemas as conventions because its usage are aspects of collective material practices of mental structures/functions.

Culture plays an essential role in another example of the schema theory of cognitive development introduced by Bruner (1990) and Nelson (1981, 1986). They found that scripts[5] are basics for an event schema because it specifies to the people participating in that event the social role they played, the action they performed, and other relations with the event (Nelson, 1986). Schema therefore is used for event presentation and action guidance, especially among children, but also adults encountering new objects, people, and events (Nelson, 1981). This experience provides a framework to interpret experiences in people’s daily life (Bruner, 1990). In the present research, I am viewing culture as the wider framework within which to explore women’s social constructed stereotypes, and attitudes, contributing to the phenomenon of women underrepresentation in STEM fields especially at the higher education level.

Therefore, culture could best be defined in this thesis as the broader field in which the collaboration of attitudes, behaviours, and symbols are shared by a large group of people and

[5] Scripts are an especially important kind of schema for purposes of thinking about the role of culture in cognitive development as they represent the everyday, culturally organized events in which people participate.

passed on overtly and covertly through generations (Shiraev and Levy, 2020). Within the cultural context, psychology views a tripartite model of prejudice development including cognitive (stereotypes), affective (attitudes), and a behavioural component whereby stereotypes represent the cognitive component of these often implicitly learned beliefs (Kaiser and Wilson, 2019). Attitudes contain the affective 'beliefs' (e.g., ideological, political), values, general knowledge (empirical and theoretical), opinions, superstitions' that may surround these stereotypes (Shiraev and Levy, 2020, p.4). Behaviour contains a variety of acting out of norms, roles, habits, customs, traditions, etc. In addition, symbols present things or ideas; however, the exploration of semiotics and cultural symbols is not addressed in this thesis. Instead, the role of culture in developing potentially self-relevant stereotypes, sexism, and the behavioural implications of each are carefully explored in the two distinct cultural contexts of the UK and China.

3.2 Cross-cultural Theories and Research

3.2.1 Cross-cultural Perspectives in Psychology

Globalism is defined as different scopes or systems connected internationally and is applied in different contexts (Steger & James, 2010). Globalism seems to be a trend in today's societies as people can access information and education that is not limited to their own countries. Cross-cultural knowledge exchange is happening when this occurs.

Cross-cultural psychology aims to study "similarities and differences in individual psychological and social functioning in various cultures and ethnic groups" (Kagitcibasi & Berry 1989, p. 494). These cross-cultural psychological studies try to explore universal principles to interpret different behaviours across different cultures (Sinha, 2002; Brislin, 1993). In particular, they compare data collected from different cultures and find the cultural differences and commonalities (Triandis, 2000).

Relevant to the present research, culture is an essential factor in stereotype development and contributes to the process of gender role socialisation, and even correlates with career choices (Correll, 2001). Other aspects might also influence women's choices regarding careers in STEM fields (see Chapter 2). Considering the cultural features of stereotypes and gendered expectations in the context of globalism, cross-cultural research critically compares a variety of cultural aspects - for instance, gender stereotypes - to understand comparatively and critically the spheres of influence on women, such as the gendering process in the UK and China. It is worth noting that psychologists now try not to interpret research on people in non-Western countries from Western perspectives and with Western psychological theories only.

3.2.2 Individualism and Collectivism

Most cultures are a mixture of both collectivism and individualism with different dimensions and features of them more prominent at different points in time (see Triandis, 1993). In individualism, the focus is on 'the centrality of the autonomous individual', whereas collectivism is centred on 'the collective-family, tribe, work organisation, consumer group, state, ethnic group, or religious group' (Triandis, 1993, p. 2). Although Hofstede (1980, 2001) initially thought of collectivism and individualism as the opposite component of one-dimension, later research argued that the collectivism-individualism is not a dichotomy and could coexist in one culture or country (Triandis, 1989, 1990). Triandis (1990) used a metaphor to illustrate this - with collectivism as 'ice' and individualism as 'water molecules within'. In this metaphor, as the environment changes, the ratio of water and ice is moving all the time. In other words, the concepts of individualism and collectivism are not bipolar in one dimension, but rather always changing within each other, and the broader society, and never all at the extreme.

Individualism is more highly found in the 'Western World', especially in the English-speaking countries (e.g. the USA) (Hofstede, 1980). This is supported by both historical (Inkeles, 1983) and empirical (Bellah, Madsen, Sullibvan, Swidler, & Tipton, 1985) research. On the other hand, collectivism could be widely found in parts of Europe (e.g. Southern Italy and rural

Greece) and majorly found in Africa, Asia, and Latin America. Some features might be highly related with individualism. Occupational differentiation is one of them – i.e. the more differentiation is found in society, it can be said that individualism would be much more popular because people could find the most suitable job for themselves to interact with the social relations, which explains that the essential direction for individualism is to find independent self among certain situations (Triandis, 1993). Availability of resources could be another aspect that can be associated with individualism - e.g. upper class and people who has extreme lack of resources (Turnbull, 1972). Furthermore, when gender role differentiation is applied, men tend to be more individualistic than women, therefore, Davis and Williamson (2019) suggested that promotes gender equality through individualistic perspectives.

As individuals, most of us carry both individualistic and collectivist patterns in our cognitive systems, but the way we apply them varies across situations. Hui, Triandis and Yee (1991) suggested that reward allocation, for instance - how much reward we might give to different societal groups - is target specific. People might be collectivist in say allocating rewards to a member of one's in-group and then change to individualism when the situation changes – e.g. competition between individuals is introduced for that reward. The elements in people's cognitive systems are diverse, people who have individualistic trends could be said to have some features such as competitiveness, self-reliance, and the desire to be unique (see full list in Triandis, 1993). When these individualistic features are frequently applied in certain situations and cultures, they can become habits, which can be automatic behaviours likely resulting from well-rehearsed event schemas (Triandis, 1980). Once a habit with individualistic elements is formed, it would take people more cognitive energy to change that habit with collectivistic elements. Thus, in the context of this thesis, culture is of the utmost importance when considering social cognition approaches to how our cultural framework shapes our individual cognitions, including self-stereotypes.

3.2.2.1 Western and Confucian Approaches to Personality

This thesis argues that Western psychological theories of understanding the relationship between individuals and families stem more from individualistic perspectives. For instance, much attention is placed on personality theories from psychoanalytic, behavioural, humanistic-existential and cognitive psychology *(e.g. Breuer & Freud, 1956; Skinner, 1938; Rogers, 1942, 1951, 1992; Maslow, 1968,1969; Kelly, 1995; Bandura, 1965, 1977, 1986, 1997, 2006)*, which see personality as much more influential and predictive of cognitive structure (Giordano, 2019). These personality theories contribute to seeing individuals as independent agents who initiate automatic identities; and families are viewed as the primary influence of the psychological path of individuals as they disrupt and distort personality development. Thus, individuals need to be separated from their families' emotional suffering to allow them to fully function as persons.

In contrast to Western societies, Confucianism offers a collectivist understanding of how individuals cooperate with their families and how family impacts on individuals' personalities. Confucianism still has a strong influence on Chinese women's identity and on gender roles in Chinese society. From a Confucian understanding of being a human being, personality development takes place through an internal exchange with the social environment (others) and with one's extended family (Ames, 2011; Rosemont & Ames, 2009). The purpose of identity development in Confucian societies is to fulfil the expectations of families and others (Ames, 2011). Then, when the identity matures, the fulfilling interaction between individuals and families will become broader (Tu, 1994). The family continuously impacts on individuals' personalities until they have families of their own (Rosemont & Ames, 2009).

In brief, Confucian identity development is based on relationships with others and thus the seeking for connection with others and with one's family is very different from Western personality perspectives. Confucianism suggests that personality development relates to both nature and nurture and requires extra self-consciousness to change (Tu, 1994; Rosemont & Ames, 2009; Giordano, 2019). So, the impact of interaction between individuals and families will be sustained personality changes. Thus, Confucianism establishes a particularly strong bond between individuals and their families. When these Confucian and collectivist notions are applied together to students from collectivist cultures, they tend to have a greater social impact on students than on those from individualist cultures, particularly when it comes to pursuing one's goals (Yu & Yang, 1994). This means that students from collectivist cultures are much more easily influenced by their social environments (e.g. their families). To explain students' motivations, Socially-Oriented Achievement Theory, which is driven by Confucianism, addresses the relationship between individuals and families (Yu & Yang, 1994). The relationship echoes the differences between individualism and collectivism when it comes to understanding students' social goals - i.e. whether the goals are oriented by the students' or by the groups' goals (Yu & Yang, 1994). Makara Fuller (2019) also explored whether there are differences between students' social goals and their cultural orientations. Chinese students' social achievement goals and social development were found to be stronger than those found among Western samples. These findings suggest that the differences between Chinese and Western students stem from their cultural orientations.

Therefore, the distinctions between individualism and collectivism relate to the different relationships between individuals and their environment. Individuals in individualist and collectivist cultures tend to have different connections and relationships with their families; students with a collectivist culture background tend to be more impacted by their societies when *Confucianism* is applied. This thesis employs the individualist-collectivist distinction to understand the different ways in which the UK and China prioritise different cultural values. These theories are often applied in cross-cultural research to interpret cultural differences (e.g. Grimm, Church, Katigbak, & Reyes, 1999). However, these differences might be overstated as the distinctions between two cultures only appear when highly abstracted (D'Andrade, 2008). These differences might not be evidenced at the level of the individual but can be seen at the level of the general population, in national values or policies. Moreover, a culture might not be the same thing as a country; individual (group) differences should be observable (e.g. Matsumoto & Yoo, 2006). Furthermore, non-Western countries (e.g. China) should not be interpreted using Western theories initially (Keith, 2019), as they do not necessarily take Eastern culture into account. Interpretations should take a cross-cultural view; this is how individuals can be understood, considering their cultural norms and differences.

3.2.3 Cognitions and Culture

As discussed in Chapter Two (mainly section 2.3.1), cognition could lead to stereotypical and biased perceptions. Much work echoes Lippmann's view that stereotype is 'given' by culture and 'made' by people (e.g. Shiraev & Levy, 2016). That is, culture influences what we perceive in our environment and our experiences shape our perception; eventually this leads to culture formatting our 'common knowledge' (Shiraev & Levy, 2016). Common knowledge can be defined as the shared knowledge that is within our culture. Moscovici (1984) developed the theory of social representations to capture the communicative and cultural elements in common knowledge.

3.2.3.1 Social Representations Theory (SRT)

Social Representations Theory (SRT; Moscovici, 1984) views knowledge of the world and people as culturally based representations. Social knowledge is passed on within cultural groups to generate "common knowledge" – i.e. the understandings of social knowledge could remain and spread within cultural groups via social representations. Thus, SRT explains the "common sense" that is encountered within certain cultural groups. Another benefit of social representations is that they offer ways for people within groups to make sense of daily life and communicate with people in their groups (Moscovici, 1973).

SRT is based on processes of anchoring and objectification. The former relates to how people integrate unfamiliar information with familiar information; the latter relates to how abstract concepts become our "objective reality" (Moscovici, 1984). Moscovici (1973) argues that "social representations are cognitive systems" (p. xii). Potter (1996) also states that the formation of social representations is a cognitive process. However, SRT does not necessarily align with social cognition research. Moscovici (1997) argues that studies on social cognition ignore collective cognition processes and only explain individual social cognitive processes. In contrast, SRT includes social interactions and communication and social knowledge thus enriching social cognition theory with social-cultural concepts. For instance, when researchers compared social schemas with social representations, social representations offered explanations that were more flexible and included social interactions and communications (Augoustinos & Innes, 1990; Augoustinos, Walker & Donaghue, 2014). Relevant to this thesis, if we redefine stereotypes in terms of the concept of social representations, beyond their definition in terms of social schema, it can be said that stereotypes are social representations that are objectified socially and affectively to be shared through common understandings within social groups in society (Hinton, 2013).

3.2.3.2 Chinese Theories of Prejudice & Stereotyping

The study of psychology was largely introduced into China from Western countries after the establishment of modern psychology (e.g. Wundt at the University of Leipzig in 1897). Therefore, although Chinese students at that time were taught the same contents and used the same coursebooks as in Western countries, Chinese researchers were not involved during the early years of the development of theories and approaches to studying stereotypes. Moreover, stereotype issues were not a major research area in China until more recent years. The first retrievable journal article about stereotypes in China was an introduction of measures and theories of stereotypes from the West in 1989 (Zhang, 1989). By that time, stereotype research was already well developed in Western countries. Thus, it is fair to say that the development of modern stereotype studies in China is based on Western theories and approaches.

While it can be argued that stereotypes are a highly cultural matter, thereby making cross-cultural differences salient in this study, it can also be argued that this is not necessarily the case on a theoretical level because recent cross-cultural psychology theories view culture as an internal factor; i.e. context-bound psychology that concentrates more on natural situations and settings (Triandis, 2000). Cross-cultural psychology has also been criticised for being based on testing other cultures using Western theories (Keith, 2019). It no longer seeks universal principles in the way that cross-cultural psychologists used to do (Sinha, 2002). Cultural psychologists are more likely to observe and describe cultural phenomena as anthropologists (Heine, 2010). The principles are not primarily concerned with issues related to culture research; instead, the psychological perspectives derive from the relationship between people's characteristics and their culture (Shiraev & Levy, 2016). Thus, one of the purposes of this study is to explore the commonalities and differences regarding certain issues through a cross-cultural lens to further the research on stereotypes and enrich the field of cross-cultural psychology.

3.3 Feminism

There is no one way in which feminist movements are categorised, and there is no consensus on what feminism constitutes or is classified as. To some, feminism is a humanism; for others, it is a political vehicle for institutional change. This thesis will attempt to give a historical overview of the key features of different waves of feminism in so-called 'Western' contexts, as well as undertaking the same process for historical and contemporary movements within China. This is not to argue that these are either definitive or cohesive 'waves' or movements, but rather a relevant way to present them in the context of this thesis. This section will argue that historical and contemporary conceptions of feminism vary across different countries, and therefore feminism's development as 'waves' should be considered according to historical and cultural contexts.

3.3.1 Western Feminism

With the development of the Industrial Revolution in the 19th century, various liberation movements spread in western industrialised societies, including 'feminism'. Feminism today could be said to encompass a range of different movements and ideologies that generally aim to advocate for women's rights or pursuit of equality for the sexes. Through social transformation, theories of feminism rapidly developed, including liberal feminism, radical feminism, existentialism feminism, Marxist feminism, socialism feminism, postmodern feminism, and neoliberalism (Bandarage, 1984; Willis, 1984; Moi, 1986; Segal, 1991; Hekman, 2013; Thompson, 2002). Although the discussion of each feminist perspective is beyond the scope of this chapter, the dominant perspectives of feminism that will be used in this thesis can be described as radicalism and liberalism, alongside their additional branches of ideologies such as culturalism feminism, ecofeminism and psychoanalytic feminism - all of which have played essential roles for contemporary feminist theory development (Meyer, 2014; Warren, 1994).

As feminist theories developed, feminist movements focused on improving women’s status as part of main society – i.e. with women’s contributions to society equally acknowledged. Eventually, feminism affected the political and economic constructions within societies, improving gender equality to some extent in the western world, and increasingly across the globe. It could be argued that feminism was equated with a movement against capitalism and patriarchy in societies more broadly (Gardiner, 2002; Qiao, 2014). There are considered to be four main waves of western feminism, which is based on the different purposes and history of feminism (

, 2003). That is, waves are a metaphor that describe a certain social movement, at a certain historical time period, of the certain cultural context. In other words, waves represent certain changes in feminist ideology, which is normally equated with western notions of feminism.

The first wave of feminism involved fighting for women's suffrage, or right to vote, in the 19th and early 20th centuries throughout the western world (Sanders, 2004; UK Parliament, 2020). The second wave, termed by some as liberal feminism, began around the 1960s. Its main purpose was to get equal rights in terms of politics, education, and working (Thompson, 2002). The third wave, termed as radical feminism, focused on rights over women's physiology – e.g. fighting for fertility control for women (Willis, 1984). Finally, in the 1980s, the fourth wave stepped into various genres (Gillis, Howie, & Munford, 2004) and beginning around 2012, became associated with issues of equality and discrimination in the emerging fields of technology and social media (Cochran, 2013; Munro, 2013; Knappe & Lang, 2014). The fourth wave of feminist activism is notable as it is combined with emerging technologies (Cochran, 2013; Long, 2012; Munro, 2013; Knappe & Lang, 2014). However, Charles and Wadia (2018) argued that these are associated with the third wave of feminist activism, and do not represent a new wave. That is, the internet is seen by some as a resource for young women used for information or broadcasting, to build feminist communities, and collect their feminist identity (Della Porta & Diani, 2006). In general, the core of the fourth wave focused on justice around sexual harassment and violence against women (Chamberlain, 2017). Given the proliferation of online social media, it remains to be seen whether the fourth wave of feminism might show more global similarities.

3.3.1.1 UK Feminism

It has been suggested that we are currently in the 'fourth wave' of feminism across Western countries (Evan, 2015). However, regarding contemporary feminism in the UK, there is discussion in the literature around distinguishing from the larger content of 'Western feminism', especially considering to what extent UK feminism differs from American feminism. Some feminism scholars also argue that the 'third wave' should be re-defined with more consideration of specific national context – including non-western countries and young feminist activism (Aune, & Holyoak, 2018).

Many scholars do not agree that UK feminism is part of the third wave of feminism because the definition of 'third wave' fails to take the diversity of feminism into account (Evan & Chamberlain, 2015; Nicholson, 2010). For instance, and Holyoak (2018) point out that when thinking about UK feminism, it should not be through an "American perception" because some perspectives of third wave feminism do not apply completely to UK feminism – e.g. radical feminism was supported by some UK feminist orientations (Mackay, 2015), but the third wave feminism was embraced with post-structuralist and post-colonial feminist theories (Mann & Huffman, 2005), given the UK's colonial past, there was more questioning of hierarchies within society more general, as well as more Marxist socialist system critiques, less likely to be embraced by the USA, given its history of anti-Marxist ideology.

Thus, although the perspective of feminism in the UK is situated within western feminism and therefore shares many similarities with American feminism, there are arguments for differentiating feminism within American and UK cultural contexts, particularly in relation to their links to social movements against capitalistic and colonial structures (Charles & Wadia, 2018). To some extent, it can be said that third wave feminism stemmed from the American context; whereas the UK was more influential in leading the first two waves (Gill & Scharff, 2013), and so feminist activists in the UK may reject the notion that they were/are part of the third wave of feminism (Evans & Chamberlain, 2015; Kempson, 2015; Mackay, 2015). In other words, the third wave of feminism, even as a 'western notion', fails to reflect a diversity of feminism as exemplified by the differences within American and UK society. Thus highlighting the importance of taking cultural context into consideration.

The other concern of the current feminism in the UK is that it ignores the concerns of young women in the UK, marginalising them from older conceptions and labels of what it means to be a 'Feminist'. On the one hand, younger feminists may be using the internet to set out their ideologies of feminism, fight negative stereotyping from a more grassroots mechanism, and construct their political identity and mobilise women (men) on the internet (Charles & Wadia, 2018). At the same time, however, this newer wave of feminism may also heighten potential harm to women as targets of gender-based internet abuse (e.g. illegal pornography). Social media may also be associated with younger women's feminist activism, such as 'armchair activism' seen on Twitter feeds.

3.3.2 Chinese Feminism

Modern and contemporary feminism has a rather shorter history in China, given the nation's later entry into 'modern' industrialised society. Thus rather than four waves, the timeline of Chinese feminism can be considered in two phases: before the 20th century and during the 20th-21st century.

Before the 20th century, China was a society with a predominantly traditional patriarchal order, where women could not fight against the system overtly. Furthermore, ancient Chinese fields of thought, such as Confucianism, continue to have an impact on the Chinese ways of being, particularly for Chinese women and gendered attitudes in China. From the 20th century, Chinese feminist thoughts were spread amongst the educated 'elite' – e.g. students and intellectuals. The New Culture Movement, which was a part of the Chinese Revolution, led the feminist movement in the early 1920s and could be considered as the end of the Patriarchal system (Wang, 2019). Reformative ideology, such as equal education and marriage rights, also guided the women's movement (Chen, 2002). There were no overtly named feminist theories in China at this time, but the core thinking behind this movement was around general equality of rights, including for men and women (e.g. Li Dadiao & Chen Duxiu). The movement fought for women's liberation to gain education, political, and marriage rights since (Qiao, 2014). However, not all equities were achieved completely – e.g. monogamy (Wang, 2019).

Overall, the results and effects of this first phase of Chinese feminism were quite limited. Although feminist thoughts were widespread after the PRC establishment following the Communist Revolution, women's rights were largely for educated, elite, and urban women; while women in rural areas or lower economic family status were left out. After 1949, Marxist feminism became the basic guiding ideology for Chinese feminism (Qiao, 2014) and the theory of class helped improve the status of women (Tong & Kang, 2004). Specifically, from the Marxist feminist perspective, the root cause for the oppression of women was seen as stemming from issues of class and capitalist systems of private ownership, which were seen to eliminate the achievement of Chinese women's liberation. Chinese feminism after the establishment of PRC was considered to be part of feminism as "a re-examination of women's roles during the communist revolution and other reform movements, and new discussions about whether women's equality has been fully achieved" (Dooling, 2005).

After the policy of open and reform in 1979, western feminism became widely accepted within Chinese feminism. For instance, Li (2014) developed Marxist feminism with a globalism feminist outlook. Interestingly, it was western scholars who initiated many of the studies about the history of Chinese women and Chinese feminism. For example, Barlow (2004) filled the research gaps of Chinese feminism history, which then inspired Chinese scholars such as Zhu (2013) to reconsider the state of Chinese feminism within its historical and political status. Later, Qiao (2014) and Li (2014) improved conceptions of Chinese feminism to enrich the picture of postmodern feminism and global feminism in the Chinese context.

Moving to a more modern conception of Chinese feminism post-PRC, a more global/outward-facing feminism could be said to be emerging, as social media contributes to advocacy for women's equal rights and status in the society. For instance, "banbiantian" - a phrase in early 20th century China that directly translates to "women could hold up half the Sky" was popularised online. The aim was to encourage women to be seen as equal and 'as strong as' men in society.

3.3.3 Chinese Feminism with Chinese Characteristics and Differ from Western

Transcultural differences can be observed between feminism in China and western countries. For example, Confucian philosophy in Chinese tradition categorise women and men with different roles in society (Brownell & Wasserstrom, 2002); the roles of men and women in ancient China use frameworks of social construction and culturally specific interpretations (Pan & Huang, 2007). On the other hand, western feminism may be more focused on natural biology gender of women and men, which has not historically been analysed in China (Spakowski, 2011), but is of increasing interest in a globalised world.

Moreover, unlike western feminism, Chinese feminism was not led by women. In the beginning, feminism in China was led by men or a group of intellectuals as “male feminism” which was distinguished as “state feminism” after the establishment of PRC in 1949. Chinese feminism, particularly its second phase, was therefore carried out as generally a “top-down” policy as opposed to western feminism’s “bottom-up” and often grassroots movement. State policy indicates that Chinese feminism should develop within a certain pathway, bearing the final targets in mind, which is seen as the whole of Chinese women’s liberation. It consists of suitable pathways for Chinese women seeking liberation, based on Chinese contemporary history and guided by political ideologies for “the products of the equality of the genders” (Li, 2003, p.17) because modern Chinese feminism began with state policy (Hu, 2016).

3.3.3.1 Combining different concepts of women from the west and the east

Barlow (2004) gave a thorough discussion explaining the understanding of the subject of Chinese women with two phrases, "nv xing" and "fu nv" [6]. They are both words representing Chinese women, but with different meanings and backgrounds in Chinese history, which distinguishes the underlying components of Chinese feminism and how western feminism has impacted on Chinese feminism These characteristics were explored by many Chinese and western scholars, which is "Bentuhua" (e.g. indigenisation) (Sharon, 2016).

[6] "nv xing" indicates that woman is the product of colonisation and modernisation, the subject of a woman is still uncompleted, part of affiliated to the subject of a man; it is more from western terms stemming from the timing before and after the New Culture Movement. "fu nv" is not a new terminology and was used in the Ming and Qing Dynasty, representing the place of Chinese women in a patriarchal society. It was given the new concepts under Matrix to enhance "the subject of women" in contemporary China after 1949, which is based on the identity social rules, marriage and ideology with specific Chinese feminism history and practical experiences from subject, social class and national levels, thus is enriching all the time with developing new concepts (Li, 2017).

Chinese feminism was rooted not only contemporary civilisation but also laid on two thousand years of feudal history of China. Thus ancient Chinese ideology combined with Daoism and Confucianism could be applied to contemporary studies because these ancient Chinese philosophies are part of the policymaking in feudal dynasties and they still could be a heuristic for the resolution of current issues. Aside from enriching current Chinese social theories and studies (e.g. Huang, Luo, Wu, & Song, 2019; Hong, & Xu, 2019; Li, 2019; Wang, & Zeng, 2007; Yan, & Liu, 2006), these ideologies also contribute to transcultural theories.

Wei (2018) stated that Daoism, for instance, could be used to interpret the holistic approaches seen in ecofeminism, with the yin and yang of the traditional Chinese way of life equating with ecofeminism's holistic emphasis on the world as a 'harmonious whole'. Likewise, Confucianism is part of the dominant ideology affecting Chinese women's sex discrimination and can be related to Chinese women's social identity. As one of the ancient Chinese wisdoms, Confucianism affects Chinese women as a conservative ideology in current social life - e.g. sex discrimination in employment is the most common issue in China, especially after women graduate from universities and colleagues (e.g. Chai, 2019; Sun, 2018; Tang, 2019; Tian, 2019; Zhou, 2019; Huang, 2018; Liu, 2018). The Confucian ethics as a patriarchal social structure that is based on the Zhou Dynasty - who inherited the throne of the 'father's power' - demonstrates how patriarchal feudal ethics evolved on the belief that the "Man is superior to woman" and "Woman is the second place after man" (Zhang, 2017). In other words, conventional Confucian thoughts influence discrimination against women (Zhou, 2014).

Confucian gender thoughts impact Chinese women's status - from physical, mental and social levels leading to proscriptive virtues for Chinese women to meet within a patriarchy-centred society. For example, the convention followed by ancient Chinese women could be summarised through "the three obediences and the four virtues", which are "Furen you sancong zhiyi, wu zhuanyong zhidao. Gu weijiacongfu, jijiacongfu, fusicongzi" (stems from Han Dian [7]). The meaning of this virtue is that women should obey their father after they are born, then obey their husband after marriage, and finally obey their son after their husband has died. This

[7] "Han Dian" is one of the classic books in Confucian culture.

spiritual dictum of wifely submission was imposed on women in traditional feudal society, and can still be seen today - particularly in rural domains (Su, 2017). With men centred in the ancient culture, women were thus traditionally treated as objects, gradually losing their self-value as women themselves, the vestiges of which can still be seen today.

Traditional Confucian culture also separated women and men into divisions of labour based on physical differences – i.e. seen as physically vulnerable and less capable of rational decisions, family events and housework should be borne by women; while ‘powerful’ physical work should be taken charge by men. Men’s priority is to develop a career, while women only focused on family and were expelled from any political events (e.g. Zhang, 2017). Similar gender labour division was found in western society with men working outside and women staying at home to care for children For example, in the UK, books about parenting were primarily aimed at mothers in the first half of the 19th century. Ellis’ (1844) *The Mothers of England: Their Influence and Responsibilities* and Beeton and Beeton’s (1982) *Book of Household Management* were embraced in the west and then introduced into Japan and combined with Confucian view of the “good wife”. As a result, woman as a “good wife” evolved with the new concepts of “good wife and good mother” reached China in the Qing Dynasty; “xianqi liangmu” (in Chinese) means “a good wife and loving mother” was a high praise for women and helped women with education rights at that time (Li, 2002). However, this became an implicit rule for women limiting Chinese women’s choices in relation to work-life balance.

Therefore, the history and differences between feminist perspectives between the UK and China would unpack similar issues with acknowledging possible underlying different cultural contexts from both countries: 1) the movements of feminism were two different types, the UK was more from the ‘bottom-up’, with a longer development than Chinese woman in contemporary society; on the contrary, Chinese feminism movement was carried mostly from the ‘top-down’ in a rather rapid time period than the Western context (Jolly & Huibo, 2018). 2) these two different types make the current trends of the UK feminism more diverse and versatile; the Chinese women might be more likely to stick with Chinese traditions, at least with a sub-conscious trend (Karl, 2012). However, globalism might be essential to narrow these differences over time. Still, the traditional culture holds strong impact and influence over the development of Chinese women in multiple dimensions within the society (e.g., Hong Fincher, 2014). 3) It is not possible to compare culture by merely comparing two cohort groups of women from two nations, however, it is possible to inform certain issues, after all, the phenomenon discussed here are the experiences of women in STEM fields as part of social lives and experienced culture. What happens in ECEC settings is an aspect of our wider society, and the character and dynamics of it are shaped by values that shape other aspects of our cultures (Alexander, 2000). On the one hand, the acknowledgement of part of feminist history and traditions from both countries is the baseline of discussing gender and cultural issues as experienced by these women studying and working in STEM contexts. In addition, it enhances the idea of cross-cultural research to understand and respect cultures within their own cultural specificity, and not only through the Western lens.

3.4 Empirical Data on Women in STEM

3.4.1 Women's Underrepresentation in STEM Fields

Although the extent of the "gender gap" varies from country to country, it remains an international issue even now. Thus, global communities and the United Nations have paid consistent attention to this issue. According to the OECD report from 2011-2018, the global gender gap is generally closing with the average distance completed to parity was 68% by 2018. Western Europe has the highest average level of gender parity (75%), compared with East Asia (68%). However, males still dominate most fields, including STEM and the most outstanding gender disparity issues lie in the field of artificial intelligence (AI), where only 22% of AI professionals globally are female (OECD, 2018). In fact, only in the fields of education, non-profits, and healthcare were women more represented than men.

Notably, the gender gap has closed in some science subjects in some countries. For instance, in 2017, women were not underrepresented among biological scientists (54.4%) and medical scientists (52.1%) in the USA (Standard Occupational Classification Manual, 2018; Bureau of Labour Statistics, 2018). As a matter of fact, more and more women are likely to pursue science through higher education globally. However, despite the rise in women studying STEM undergraduate degrees, a gender gap among PhD graduates remains. Moreover, empirical data also reveals that women are still underrepresented in STEM fields at professional levels (UNESCO, 2015; National Science Board, 2016).

3.4.2 British Women in STEM

The gender disparity in STEM fields still remains in the UK as girls are less likely to choose STEM subjects at A levels, as well as drop out of STEM careers. In 2016/17, female students accounted for only 42% of all STEM A level exam entries: 9.4% in computing, 21.2% in physics, and 39% in mathematics. Despite accounting for more than 50% of all enrolments, girls only made up about 38% of enrolments on undergraduate STEM courses (UK Government, 2017). In other words, gender disparity issues among UK women in STEM fields remain a challenge as leaking pipes of women in higher education and STEM careers continue (OECD, 2018) – i.e. the higher the level of education, the greater is the underrepresentation of women in STEM fields.

There has been a growing concern about the UK skills shortage in STEM fields and industries since the 2000s. According to a government report, nearly 50% of UK employers in STEM claimed that they are struggling to recruit people with relevant skills (UK Government, 2017, p. 51). Moreover, in 2015/2016, only 24% of graduate students in STEM subjects were working in a STEM occupation six months later (OECD, 2018). The occupation shortage in STEM fields is detrimental to economic health of the UK, which is why the UK government is making efforts to boost education in STEM fields by increasing investment in maths and technical education (UK Government, 2017).

3.4.3 Chinese women in STEM

Although gender issues have a long history in China, specific gender disparities have not been very clearly identified in research. In 2017, a Chinese public report about female representation across education levels indicated that the gender gap was almost closed, except at the PhD level: females represented 46.46% of junior school students, 50.29% of senior school students, 52.42% of undergraduate students, 52.15% of postgraduates, and 37.85% of PhD students (Chinese Ministry of Education, 2024).

Nevertheless, gender disparity still exists in Chinese STEM fields, especially in STEM higher education and careers. For instance, in the Chinese Academy of Sciences (i.e. the highest institution for science researchers in China) males accounted for 94% and females only 6% (see *Table 1-3.1*). Moreover, empirical data from the 2018 Chinese Campus Recruitment Report indicates that Chinese women are still underrepresented in the majority of STEM fields (Chinese Ministry of Education, 2018).

Gender disparity still exists in Chinese STEM fields, especially in STEM higher education and careers. *Table 1-3.1* below shows the ratios of women in the Chinese academy of sciences (the highest institution for science researchers), with males accounting for 94% and females for only 6%. Recent empirical data from the 2018 Chinese Campus Recruitment Report indicates that Chinese women are still underrepresented in the majority of STEM fields. Thus, Chinese women tend to be largely underrepresented in STEM fields, especially at higher education levels and in STEM careers.

Table 1-3.1: The ratio of Chinese female researchers in Academic divisions of the Chinese academic

Academic Subjects	Total	Female Researchers	%
Mechanical and Carry Engineering	121	3	2.48%
Information and Electronic Engineering	120	3	2.50%
Chemical, Metallurgy and Material Engineering	103	5	4.85%

Energy and Mineral Engineering	113	1	0.88%
Construction, Water Resources and Architectural Engineering	107	3	2.80%
Environmental and Textile Engineering	51	5	9.80%
Agriculture	74	3	4.05%
Medicine and Health	116	16	13.79%
Engineering Management	55	2	3.64%
Total	860	41	4.77%

(Website of the Academic Divisions of the Chinese Academic of Sciences)

Table 2-3.2: The ratio of Chinese female researchers in Academic divisions of the Chinese academic

	Ph.D.	Master	Bachelor
Graduates in total	55011	508927	3743680
Female Graduate in total	21535	269502	1995345
Female Graduate %	39.15	52.95	53.30
women in science and technology working force (%) *	193000 (0.6)	1792000 (5.8)	12313000 (39.7)
	Ph.D. Supervisors	Master Supervisors	Other Tutors
Teachers in total	18677	289127	1627182
Female in total	3093	100200	802298
Female %	16.56	34.66	49.31

Data from China Education Statistic Yearbook (2016).

**Chinese women in Science and Technology Working Force: working or able to work in science and technology fields. Data from Report of development of human recourse in technology in China*

Interestingly, the *Table 2-3.2* shows that China and the UK shared very similar scores (around 0.5) on Traditional vs. Secular Values, the UK score is slightly lower than China. On the other hand, societies with high scores (2.5) of survivals vs. self-expression values in the UK, while

China only has around -0.1. This was data from 2017 to mid-2020, unfortunately, China joined this study very recently, with no early data traceable. Only from this survey, a trend shows that the differences between the UK and China societies mainly from survival and self-expression values. Another added point to this map is the assumptions of how tradition affects Chinese society. which might have new changes in general, however, women may still have subtle stereotypes and bias from the traditional impacts passed down through the generations.

3.4.4 Gender-STEM Research in the UK and China

Cross-cultural studies indicate the international diversity of gender-science stereotypes (e.g. Miller, Eagly, & Linn, 2015). In general, implicit and explicit gender-science stereotypes have not been found to be correlated – e.g. explicit gender roles have no direct correlations with implicit gender stereotypes among college students (Dong, Xiao, & Wang, 2014). Similar results have been found for implicit maths gender stereotypes in both Chinese and Western studies of children and adolescents (Du, 2004). Relevant to this thesis, this section will focus on gender-STEM research in the UK and Chinese contexts.

Chinese researchers only began exploring gender inequality in recent decades, and research regarding women's access to and retention in STEM fields of study and career is still in its early development. Nevertheless, some results are quite congruent with findings from Western research. For example, IQ test scores show no direct relationship with STEM careers (Zhang, Chen & He, 2008). The most highly related associations with dedication to STEM careers appear to be personality traits such as being hard-working and persistent (Zhang et al., 2008). Teachers, parents and role models (e.g. scientists) are also found to be influential in women's decisions regarding a STEM career (Zhang et al., 2008). Likewise, Wu and Huang (2008) found that few Chinese women are in higher level STEM careers, echoing the so-called leaky pipeline found in Western research. The inequality faced by Chinese women in STEM higher education and skilled employment suggests similar impact factors as those to be found in the findings of Western research. That is, parents and teachers play a vital role in the process of gender socialisation and affect children with their own gendered beliefs. However, despite emerging research on gender inequalities in STEM within a Chinese context, there remains a dearth of comparative research exploring differences in gender-STEM stereotypes between the UK and China.

On the whole, gender stereotype studies in UK contexts do not attract a great deal of research interest. One reason could be that gender-STEM stereotypes are nowadays viewed as a global issue rather than a localised one (Ahmad & Greenhalgh-Spencer, 2017); i.e. researchers are more concerned about the common features of gender stereotypes. Another reason for the lack of research could be that after receiving such massive attention, gender research is now moving on to a new phase of policymaking; i.e. gender equality issues are discussed more often in government reports (e.g. HM Treasury, 2017; Advance HE, 2020). On the other hand, Chinese researchers tend to focus more on experimental gender research regarding gender stereotypes. For example, in Zuo and Liu's (2006) research, male students – in contrast to female students – were found to still hold traditional gender stereotypes (e.g. Chinese women were associated with being good wives and assuming traditional gender roles). Researchers have also found similar implicit gender maths-stereotypes among primary, middle-school and college students using implicit association tests (Du, 2004; He, 2006). For gender-science stereotypes, research suggests that Chinese women and men both have implicit gender-science stereotypes (

, Zhou, & Shi, 2001). Xiang (2009) further suggests that social media has a negative impact on passing on gender-stereotypes among society, including stereotypes of women working in STEM fields. However, the most influential factors are the family and policies for STEM fields (e.g. Li, 2009; Zhang & Liu, 2013). For example, Li (2009) found that parents' and teachers' gender bias have an impact on girls' early education in physics learning – e.g. among women working in STEM fields, the strongest pressures they experience come from their families as Chinese women always put family first before their careers. Yang and Gao (2019) further address the cultural impact of Chinese patriarchal beliefs transmitted through parents' expectations, which can lead to gender stereotypic beliefs related to lower career expectations, and in turn result in Chinese women being less motivated.

Although the UK has achieved greater overt gender equality than China (OECE, 2018), the empirical data discussed above suggests that the two countries might share similar issues in STEM fields, particularly in relation to the leaky pipeline within STEM careers. According to literature reviewed, it can be said that women from the UK and China may perceive lower expectations from their parents and teachers regarding maths and related careers, which might lead to them having lower aspirations for and motivations to engage in STEM-related careers. At the heart of this may be society's associations of science with boys and more traditional communal gender roles for girls – i.e. women in both countries may come to consider maths, computers, science and technology as agentic or masculine domains (Li & Kirkup, 2007). In fact, preliminary findings from both countries suggest that men dominate in domains such as confidence with maths, ICT computer use, and consistently achieve higher scores on maths and maths-related subjects in school.

4. CHAPTER FOUR: MIXED METHODOLOGY AND RESEARCH DESIGN

4.1 Methodological Approach Underlying Philosophical Assumption

This chapter will explain the methodology used in this study, including the philosophical assumptions, why and how a mixed-methods approach was adopted, and the rationale for this research design. It begins with an overview of this research and aims applied, and next the adopted methodology will be explained from the perspectives of the philosophical assumptions and the research design. It will also discuss the philosophical assumptions relating to the quantitative, qualitative and mixed methods used in this research. The underlying theories will be discussed as to why implicit and explicit methods were employed to explore the gender-science stereotype, and why a sequential explanatory mixed methodology was selected for this research. At last, the research questions will be addressed.

This first section sets out to describe the methodological approach selected for this research and its underling philosophical assumptions. The concept of methodology, rather than research method, is used here because the former is not restricted to any specific methods and data collection techniques. Instead, it reflects the collection of ontological, epistemological and ethical considerations, and the general preference regarding overall design, guidelines for making inferences, and criteria for assessing and improving quality (Teddie & Tashakkori, 2009, p.21). These aspects are explained as follows.

4.1.1 The use of quantitative methods

According to Kuhn (1962), a research paradigm is ‘the set of common beliefs and agreements shared between scientists about how problems should be understood and addressed’. The paradigm can be characterised in terms of ontology, epistemology and methodology (Admiraal & Wubbels, 2005, p. 315). Ontology is the study of being and is regarded as the nature of existence and reality. Epistemology indicates ways of knowing and is regarded as the nature of knowledge. Together, these aspects help to determine the assumptions and beliefs that construct the researchers' view of a research question, the ways in which the research question will be investigated, and the methods used to achieve the research goals. Methodology refers to the investigative approaches used in the research, such as the tools and techniques (Denscombe, 2002; Guba & Lincoln, 1994; Bryman, 2016).

It is suggested that particular paradigms are associated with certain methodologies. In general, the positivist paradigm usually assumes a quantitative methodology, while an interpretivist or constructivist paradigm usually assumes a qualitative methodology. Therefore, which research paradigm should be used? Answering this question is rather difficult, and, to some extent, requires pragmatism. Generally speaking, every research paradigm contains weaknesses and strengths. Thus, it is very important for the researcher to think critically about the specific challenges and strengths of using certain research approaches, and to design the research in such a way that it attempts to eliminate the challenges, resulting in the collection of reliable and valid data. In the following section, a brief review of the research paradigms is presented.

4.1.1.1 Positivism/Post-positivism

The positivist/post-positivist paradigm of exploring the reality is based on the assumptions that observation and reason are the best ways of understanding human behaviours; true knowledge is based on the experience of the senses and can be obtained by observations and experiments. At the ontological level, positivists/post-positivists believe that the reality of the world is objective and independent of the researcher's interest in it. Positivists believe that reality is quantifiable, measurable, and can be broken into variables. Post-positivists support this understanding of reality but suggest that research could uncover the reality within a certain realm of probability (Ponterotto, 2005). At the epistemological level, the positivist/post-positivist paradigm assumes that human knowledge can be tested empirically (e.g., Eichelberger, 1989). The research approaches associated with this paradigm are quantitative and involve data collection and analysis using questionnaires, observations, tests and experiments. The research data is objective and independent of the researcher's interest and values. At the methodological level, the research goal of positivist/post-positivist design is most commonly related with uncovering the facts and predicting behaviours (Bogdan & Biklen, 2007). Specifically, the purposes of research that adopts this paradigm may include predicting results, testing theories, or examining correlational or casual relationships between variables. Variables in the positivist/post-positivist paradigm are defined as those used or measured or observed. Research results can be replicable if the same procedure and methods are followed.

4.1.2 The use of qualitative methods

The research questions and the goals of my present work informed the methodology to be used. As discussed above, a quantitative research approach is usually employed to examine the causes of events, or the correlations between events, under specific conditions, and involves a deductive approach to problem solving (Tashakkori, Teddilie & Teddlie, 1998). A quantitative approach is very useful for answering research questions that require the drawing of meaningful conclusions from numerical or probabilistic values. The purpose of the current research in the first phase was to determine whether Chinese and British females hold gender-science stereotypes. To be more precise, this research aimed to uncover whether there were group differences in the implicit and explicit gender-science stereotype between women studying in STEM subjects and women studying in non-STEM subjects in the UK and in China.

This type of research is labelled ‘positivistic’ and tends to use hypothetic–deductive methods. In this sense, the present work required (1) a highly structured research design, and (2) a highly objective approach, not only for the research design, but also for the researcher and the participants. For example, the research should not be part of what the researcher observes, so that he/she does not bring his or her own interests, values and biases into the research. Similarly, the research should not be part of what the participants think and believe. It is also important that the results of the work are determined numerically or statistically, and they should be replicable using the same research paradigm. Moreover, the variables (dependent and indecent variables) should be pre-defined. Given these considerations, a quantitative approach was deemed most appropriate for the present work since it provides an exact measurement of the efficacy of the research design and research questions in the first phase.

There is a tendency for quantitative and qualitative research methods to be regarded as embodying different methodologies, but there is also debate as to whether this division really exists. Scholars have expressed doubts about to whether the differences between qualitative and quantitative research indicate a difference in methodological approaches for a particular study. Rather, at the beginning of a research study, attention should be paid firstly to the selection of a research paradigm and the designing of a plan for pursuing the methodology within the chosen research paradigm (Creswell, 1994; Morse, 2003).

A research paradigm is the relationship between ontology, epistemology and methodology (Admiraal & Wubbels, 2005, p. 315). In fact, it can be viewed as a set of basic beliefs which define the nature of the world, the individual's place in it, and the corresponding possible relationships between different parts (Guba & Lincoln, 1994, p. 107). "Ontology" refers to our conceptions of social reality and research objects, while "epistemology" indicates the values I hold in understanding knowledge. Specifically, it is related to how I understand knowledge and what kind of knowledge is possible in the study of the social and human world (Delanty & Strydom, 2003). "Methodology" refers to the investigative approach consistent with these above principles (Guba & Lincoln, 1994, pp. 108-109; Denscombe, 2002; Bryman, 2016). Therefore, studies starting from different ontological, epistemological and methodological beliefs may lead to different research approaches and outcomes (Admiraal & Wubbels, 2005, p. 315). Referring to the classification in Denzin & Lincoln's (1994) work, a brief review of the research paradigms proposed in my research is presented below in.

4.1.2.1 Interpretivism/Constructivism

The interpretivist/constructivist paradigm serves as an alternative to positivism/post-positivism. At the ontological level, the interpretivist/constructivist paradigm assumes that the nature of the reality is socially constructed (Mertens, 2009) and consists of individuals' subjective experiences and interpretations of the external world (Walsham, 1993). In this view, multiple realties exist due to the varying human experiences (e.g., varying knowledge, experience, and interpretations). At the epistemological level, the interpretivist/constructivist paradigm holds that knowledge and meaning are understood through interpretations and observations, and there is no objective knowledge and meaning that is independent of human mental processes (Deetz, 1996). At the methodological level, the interpretivist/constructivist paradigm focuses on individuals' experiences. The paradigm is usually associated with qualitative research methods applied in a natural setting. Interpretivist/constructivist research does not predefine the variables (e.g., dependent and independent variables). The research questions tend to be open-ended, descriptive and non-directional (Creswell, 1994), and pay attention to details and contexts. The techniques used for data collection vary depending on the research questions, the research design, and the nature of the participants. They may include interviews, focus groups, personal and official documents, and observations.

The second phase of research necessitated a more interpretivist point of view, as the experience of Chinese women was under-researched and less strongly theorised than the quantitative hypotheses. This phase rather posed research questions around. Qualitative methods were chosen for this research because of the predominant use of quantitative methods by other researchers when examining gender-science stereotypes, especially by IAT. Furthermore, it was deemed that the research questions could best be answered through qualitative methods due to the exploratory, inductive nature of the study. The aim was to elicit detailed descriptions of gender-science stereotyping of women, especially women in STEM subjects. During this phase, the participants could draw on their own experiences, rather than rely on making assumptions about how and why they have or do not have gender-science stereotypes. Additionally, as the aim was to exam the predominately Chinese STEM sample, and the subtle role that parents may play in this, the investigation could best be carried out through methods that allowed the participants to describe their thoughts and feelings in their own words.

4.1.3 Limitations and strengths within quantitative and qualitative methods respectively

The main consideration in research design is establishing which method is most appropriate for achieving the aims of the study (Jones, 1995; Silverman, 2013). Therefore, the relative strengths and weaknesses of quantitative and qualitative methods are assessed in relation to the research aims. Quantitative methods are usually more suited for statistical summaries and comparisons of large datasets (Lewin, 2005). Quantitative methods often derive from a positivist approach 'based on the belief that phenomena can be reduced to their constituent parts, measured and then causal relationships deduced' (Baum, 1995; p. 461). Quantitative methods tend to involve a deductive approach to psychological research to prove or disapprove hypotheses. They are therefore often criticised as deductionism, researcher might be focusing on the research questions themselves and ignoring the real human experience and behaviors in reality.

On the contrary, qualitative methods involve a phenomenological approach, whereby theory emerges from the data to explore research questions and answer the "how" and the "why" (Power, 2002; p. 87). Qualitative methods are employed to gain a deep understanding of individuals' and societies' behaviours and influences and can be used to tackle the 'messy background noise' (Baum, 1995; p. 459). Thus, unquantifiable variables are essential to indicate how people view and make sense of their own world (Harding & Gantley, 1998; Blaikie, 2000). However, qualitative approaches are often criticised as reductionism because they might overlook at the richness of experience and human behaviors. Therefore, qualitative and quantitative methods were both needed and raised the internal connections from those two phases of research. To fill this connection, a mixed-methods research was required, and mixed-methodological approaches will now be considered.

4.1.4 Emergent: mixed-methods research

4.1.4.1 Mixed-methods research design: a "third wave"

Scholars propose that factors of "explanation" and "exploration" could provide a standard which can be employed for deciding whether a quantitative or qualitative study is suitable for addressing research questions (Crewell, 2012). An important characteristic of quantitative research is that it tries to explain or predict relations among variables, while qualitative research tries to explore and understand the nature of a particular situation. Based on a review of the research paradigms for conducting research, it is incumbent on me to identify an appropriate position with which to align my own research. Having examined carefully the research questions and the conceptual framework for this research, I believe that both quantitative and qualitative methods are useful for achieving my research aims. This study explores not only female students' specific implicit and explicit attitudes and stereotypes according to the theoretical framework, but also examines the female students' explicit attitudes and experiences of being in STEM fields, in order to understand the patterns of women pursuing successful at high-level of educations and careers in STEM fields from both countries. Therefore, it would appear that a single paradigm (interpretivism or positivism) would not be capable of successfully addressing the research questions posed in my research. Hence, the proposed third wave (Johnson & Onwuegbuzie, 2004, p.17) (mixed-methods research) would seem the perfect solution for my study.

Some scholars during the 1970s and the 1980s saw quantitative and qualitative approaches as embodying separate paradigms, while others saw the potential in combining the two techniques (Guba & Lincoln, 1989). Mixed-methods research subsequently developed as a separate paradigm, offering a consistent procedure for collecting, analysing and mixing both quantitative and qualitative methods in a single study or a series of studies to understand a research problem (Creswell & Plano Clark, 2018). The underlying assumption when conducting mixed-methods research is that a 'combination of quantitative and qualitative approach provides a better understanding of research problems than either approach alone' (Creswell & Plano Clark, 2018, p. 9).

Although the procedures involved in mixed-methods research are time-consuming and require professional skills for data collection and analysis, there is a growing group of scholars that support the mixed quantitative and qualitative research paradigm. When used in combination, quantitative and qualitative methods complement each other and can provide a more complete picture of the research problem (Greene et al., 1989), thus generating a very powerful mix (Miles & Huberman, 1994). A mixed-methods study ‘gathers more information in different modes about a phenomenon’ and the breadth of findings highlights shortcomings in individual methods (Grant & Giddings, 2006). Greene and his colleagues

(1989) further argues that mixed-methods research can help expand the basic research focus to develop wider implications. The complexity of research problems demands answers that are beyond ‘simply numbers in a quantitative sense or words in a qualitative sense’ (Creswell & Plano Clark, 2018, p.13). This is exactly the case in my research.

It is important to consider how the application of research methods reflects the chosen paradigm (Giddings & Grant, 2006). The mixed-methods approach reflects the research paradigm in my study. On the one hand, the conducting of a questionnaire indicates a positioning at the positivist end of ontology, as it aims to test the proposed relations and discover general information from the research sample. In addition, conducting a questionnaire ensured that the relationship between the researcher and the respondents did not interfere in the data, thereby helping me to separate my own perspectives from those of the respondents to allow more objective judgments to be made about the data. On the other hand, the interview technique lies at the interpretivist end of ontology, for it attempts to gather more individualised information and reflect personal perspectives. The researcher tends to develop an interactive relationship with interviewees in order to understand their situation. Reflecting on the discussionon ontological and epistemological positions, it is clear that the mixed-methods approach does not mean the combination of different research methods, but, rather, the combination of different research paradigms in separate stages of the research process.

4.1.4.2 The explanatory sequential strategy

There are four basic designs of mixed-methods research have been proposed: the convergent parallel design, the explanatory sequential design, the exploratory sequential design, and the embedded design (Creswell & Plano Clark, 2018). A brief introduction to these four designs is provided in Creswell & Plano Clark’s list in Figure 2-6.1, using abbreviations to indicate QUAN(titative) and QUAL(itative) and symbols to signify their sequence and relative importance to the research (Creswell, 1994; Morse, 2003; Creswell & Plano Clark, 2018). One example of a sequential explanatory study is Ivankova & Stick’s (2007) two-phase project researching higher education (Ivankova & Stick, 2007, p. 93). The way to tell the difference between these designs is based on four criteria: the priority of quantitative and qualitative data collection, the sequence of each method, the analysis methods, and the mixed techniques within a study (Creswell & Plano Clark, 2018). The proposed sequential mixed-methods strategy (Teddlie & Tashakkori, 2003) serves as a useful guide for my small-scale research inspired with my researches aims and theoretical frameworks. The research priority of my study is in the quantitative phase. This stage is conducted first in the sequence and has the research purpose of revealing the general situation regarding students' attitudes and experiences of gender and STEM fields. The quantitative data is then used to guide and inform the qualitative data analysis. Qualitative methods are used in the second stage to elaborate and refine results obtained from the quantitative data, e.g., to obtain more detailed and specific information, to explore some typical cases or follow up some extreme cases, and probe issues related to the research questions in greater depth.

Kemshall's (1998) concept of the "inductive spiral" is often used to describe a research methodology based on separate stages, as the spiral could help to present a clear map of a research route where 'reasoning moves from inferring general statements from singular ones, to finally deducing singular statements from general ones' (Kemshall, 1998, p. 22). My version of the inductive spiral is shown in *Figure 4-4.1*, on the next page. It illustrates my ontological/epistemological standpoints, my methods of data collection and analysis, my research aims in each research stage, and my further reflections on the reviewed literature to lead to my findings. This concept provides a useful tool for my research process: while data collection is being carried out, reflection can be made on received knowledge in the research area, which in turn contributes to the findings and informing the next. All these methodologies inspired how I conducted my own research methods, after I summarise different approaches mixed-methods design, then I will discuss how the methods developed gradually into a sequential explanatory mixed-methods design detailed below.

Figure 4-4.1: The four primary models of mixed-methods design (Creswell & Plano Clark, 2018)

The convergent parallel design:	the most common approach. This is usually one-phase study using parallel quantitative and qualitative methods: QUAN +QUAL
The explanatory sequential design:	A two-phase approach where (usually) qualitative data is used to build on quantitative data collected in an earlier phase. It is best suited to situations where the researcher requires additional qualitative data to support findings from a quantitative study or where a broad data set is used to support a more detailed and tightly focused study. QUAN → QUAL
The exploratory sequential design:	A two-phase approach where (usually) specific qualitative findings are further explored through a more general quantitative study. QUAL →QUAL
The embedded design:	This technique embeds one method within another to support the findings from the primary method. QUAN(qual)

4.2 Mixed Methods: A Sequential Explanatory Design

4.2.1 Procedural Overview and Rationale for the Mixed-methods Sequential Explanatory Design

In any mixed-methods research design, there is a need to deal with issues of priority, implementation, and integration of the quantitative and qualitative approaches. Thus, I had to consider how much weight to apportion to quantitative or qualitative methods in each phase of this study design; establish the sequence of the quantitative and qualitative data collection and analysis; and decide where to integrate these two approaches in the actual data. Furthermore, I had to visually represent our study design in terms of our own conceptual purposes to make it comprehensible for readers and reviewers. Thus, to address all of the issues discussed above, the entire design was conducted in accordance with the purposes of our study, and in line with the methodological discussion in the literature review (Morse 1991; Morgan 1998; Tashakkori & Teddlie 1998; Creswell & Plano Clark, 2018).

4.2.2 Priority/Weight of Each Phase and Sequence

"Priority", here, refers to which approach a researcher apportions more weight or attention throughout the data collection and analysis process in the study (Morgan 1998; Creswell, 2012). This is a difficult decision to make (Creswell, 2012), and it might depend on the researcher's own interests (or those of the readers) regarding where the study's emphasis lies (Creswell, 2012). The weight of quantitative and qualitative approaches is often based on the sequence of the design. The major aspect always comes first in the process. In the sequential explanatory design, the priority might be given to the quantitative approach as the quantitative data collection always accounts for the majority of data collected in a mixed-methods design. However, a researcher could give equal priority to both approaches based on the purposes of the study and the scope of the quantitative and qualitative research questions (Morgan, 1998). These decisions could be made during the study design stage before the data collection, or later, during the data collection and analysis process.

At the very beginning of this study, it was not clear how much weight should be placed on the second phase. This decision was ultimately made after the end of the Phase One data collection and analysis had been conducted. I required deeper understandings and explanations for what I had found in Phase One. Our decision was influenced by the study's focus on exploring gender-science stereotypes and identifying the factors that influence women from two different cultural backgrounds. Therefore, the two phases were assigned the same weight in this study to explore the research questions in depth from different perspectives.

The first phase of the study focused primarily on exploring and revealing the predictive power of the different states of gender-science stereotyping among female students across two nations and what factors might affect these states. I used statistical data analysis to obtain as much information as possible. The goal of the quantitative phase was to reveal potential influential factors. Data obtained for the two national backgrounds were compared in order to address the research questions in a statistical way. For the quantitative analysis, I decided to use descriptive statistics (two by two ANOVA, independent t-test and correlation) to compare women from different subjects and countries and their implicit and explicit attitudes towards gender-science stereotypes.

In Phase Two, I explored and interpreted the statistical results obtained in the quantitative phase. To enhance the depth of the qualitative analysis, I decided to use semi-structured focus groups and interviews, which could generate extensive data from different sources, as well as provide for multiple levels of data analysis. I performed a thematic analysis on the multiple levels of data, using themes and categories to compare individual and cross-cultural experiences, and applying both inductive and deductive methods for interpreting the qualitative data.

4.2.3 Study Implementation/Procedures

"Implementation", here, refers to whether the quantitative and qualitative data collection and analysis processes occurred in sequence, one after the another, or whether they were performed at the same time (Greene, Caracelli & Graham, 1989; Morgan, 1998; Creswell, 2012). In the sequential explanatory design, the data were collected over a period of time in two consecutive phases. For instance, first, the quantitative data were collected and analysed, then researcher collected the qualitative data relating to the quantitative results obtained in the previous phase. The sequence of quantitative-qualitative data collection and analysis depends on the purposes of the study in the search for contextual field-based explanations of the statistical results (Greene & Caracelli, 1997; Creswell, 1994).

In this study, I collected the first quantitative data using a lab-based test called IAT, and this was followed by a questionnaire. This phase was to test the hypotheses identified in the literature review and identify the potential factors that might influence female students' attitudes regarding gender-science stereotypes. This phase could incorporate the predictive power of selective variables and comparisons of two different groups of female students, which allowed for the purposeful selection of the informants for the next phase of the study. I then collected and analysed the qualitative data to help explain why the implicit and explicit attitudes identified in the first phase were significant or not significant predictors of female

STEM students' attitudes. Thus, the quantitative data provided statistical results for a general identification of the implicit and explicit attitudes of female students and some potential factors that might influence gender-science stereotypes. By analysing the qualitative data, I attempted to explain why the implicit and explicit attitudes significantly or not significantly affected the female students and identify which other factors might be involved.

4.2.4 Integration

"Integration" refers to the stage or stages in the research process wherein the mixing or integration of the quantitative and qualitative methods occurs (Greene et al., 1989; Tashakkori & Teddlie, 1998; Crewell et al., 2003). This integration could occur at the beginning of the study when the purpose is formulated and the quantitative and qualitative research questions are introduced (Teddlie & Tashakkori, 2003), or the quantitative and qualitative findings might be integrated in the interpretation stage of the study (Teddlie & Tashakkori, 2003). Furthermore, in mixed-methods sequential designs, the quantitative and qualitative phases are connected (Hanson, Creswell, Clark, Petska & Creswell, 2005). They are also connected in the intermediate stage, when the results of the data analysis in the first phase of the study inform or guide the data collection in the second phase. In addition, in the sequential explanatory design, a researcher would also connect two phases when selecting participants for the second phase analysis based on the results of the first phase (Creswell, 1994). Another connecting point would be the development of protocols of qualitative data collection grounded in the previously obtained quantitative results to investigate the reality in greater depth by collecting and analysing the qualitative data in the second phase of the study.

Therefore, the approaches to designing, conducting, analysing, and writing up this thesis were all developed within an interpretative framework. Hesse-Biber & Leavy (2010, p. 78) defines the interpretative approach as the 'interpretation of interactions and the social meaning that people assign to their interactions. Social meaning is created during interactions and by people's interpretations of interactions.' My approach questions objectivity, or the existence of "truth" within social reality, whilst attempting to situate the findings within the wider relational and structural context of the implicit and explicit gender stereotypes. In order to fully integrate this approach in this study, I planned to explore the participants' understandings and interpretations of their experiences of gender-STEM stereotypes in STEM fields. The aim of collecting qualitative data is to gain more detailed and in-depth perspectives through a textual lens to enrich the understanding of the phenomenon being studied. As each type of data fits different needs, combining different forms may logically provide a more complete picture to make sense of the research topic. These multiple types of data will help build up the conceptual framework and the themes for the second quantitative phase. Multiple data reflect an attempt to enhance an in-depth discussion by offering rigour, breadth and depth for inquiry (Creswell & Plano Clark, 2018). This intention to achieve breadth and depth is what drove me to adopt a mixed-methods research approach. I adopted several strategies to achieve this goal as summary in *Table 3-4.1* below.

Table 3-4.1: Steps within the sequential explanatory design

Step	**Procedure**
Phase 1 Quantitative Data Collection	IAT procedure to measure implicit stereotypes and questionnaire to measure explicit stereotypes
Figure 5-6.1: Steps within the sequential explanatory design	Figure 6-6.1: Steps within the sequential explanatory design
Connecting Quantitative and Qualitative Phases	Develop interview/focus group questions to explore findings more deeply and to examine wider cultural influences on quantitative phase results
Phase 2 Qualitative Data Collection	Focus groups with Chinese and UK female STEM postgraduates, and in-depth interviews with Chinese experts working in the field of STEM in the UK
Phase 2 Qualitative Data Analysis	Thematic analysis for the postgraduate focus groups, and IPA for the in-depth expert interviews
Integration of Quantitative and Qualitative results	Triangulation in order to interpret and explain the quantitative and qualitative results holistically

This Table structures the stages of this thesis according to Six steps to sequential explanatory design recommended by Ivankova, Creswell, & Stick (2006).

The first phase was to detect the explicit and implicit gender-STEM stereotypes expressed by a sample of women from both countries, demonstrating women 's attitudes towards STEM (compared with non-STEM) fields from both countries. however, it limited for us to understand why women could represent in higher level education and careers in STEM fields, the second phase helps to dig deeper, as the focus groups helped to explore the the influential impacts for women to achieve in STEM fields from both countries successfully entering postgraduate study. Furthermore, the interviews gave us a close look at the pathway how Chinese women achieve and maintain high-level careers in STEM fields (in the UK), deepening the understanding of differences from cross-cultural perspectives of working in a different cultural context to one's own upbringing.

Also, the quantitative and qualitative phases data collection were connected during the intermediate stage for selection criteria of specific groups of qualitative participants in part based on the results of the quantitative phase. The two phases were also connected when developing the focus group and interview questions for the second phase data collection, based on the statistical analysis of Phase One. The different analysis methods applied in two phases will explain in the following chapters. Lastly, the results and interpretations obtained during the quantitative and qualitative phases were integrated in the final triangulation discussion. Based on arguments in prior chapters, the hypotheses and aims for each phase are outlined in section 4.6 below.

4.3 Measurements of Explicit and Implicit Gender Stereotype

The various theories of feminism and stereotypes outlined and discussed in Chapters One to Four have guided researchers exploring the operationalisation and measurement of stereotypes. This chapter will review why both explicit and implicit measurements are required to measure the content of gender stereotypes and their application in modern societies. It will discuss the development of direct (explicit) and indirect (implicit) measures of stereotypes, and particularly, how specific forms of measurement were chosen for Phase One of the present study to direct data collection regarding explicit and implicit gender stereotypes.

4.3.1 Explicit Measurements Related to the Relative Position of Men and Women in Society

Within the quantitative phase itself, it is important to consider the ways in which stereotypes and prejudice may be operationalised and measured. I have seen where historically feminist research has stemmed from, but psychological forays into the measurement of feminism and sexism began with direct measures of overt attitudes in the 1970s; these will now be reviewed broadly here. This section will examine the measurements used to assess sexism and feminist identity (Thompson, Pleck & Ferrera, 1992); that is the scales for measuring discrimination and prejudice that women are believed to have experienced during their endeavours to achieve "egalitarianism" and a feminist identity. The original feminist identity model derived from Downing and Roush (1985), who argue that individual experiences differ from society's perceptions of equality. With the changing forms of sexism, the measures of feminist identity have also been modified in different periods. Thus, different scales were used to detect them.

4.3.1.1 Attitudes toward women scale (AWS)

One of the most popular and among the first measures of feminism was developed at a time when psychological research was both encouraging and robust and was influenced by the feminist movement and the major events of the period. AWS stems from the original 55-item scale of Spence and Helmreich (1972), and based on substantial and replicative research development, was reduced to a 25-item scale (Spence, Helmreich & Stapp, 1973) and finally a 15-item scale (Spence & Helmreich, 1979). The AWS was designed to explore and assess beliefs about women's (equal) rights among men and women, along with perceptions of gender events. As Eagly and Mladinic (1989) argue, the AWS is more accurately described as a scale of attitudes toward women's rights, rather than as a measure of women's attitudes. With the passing of time, the AWS has become less frequently used. It has been criticised in terms of its validity and the items used in the scale (Smith & Epstein, 2010). Based on the data derived from using the AWS for two decades, Spence and Hahn (1997) state that women already hold significantly less traditional attitudes than men do.

4.3.1.2 *Old-fashioned sexism (OFS) and modern sexism (MS)*

Both traditional and more recent explicit measures of sexism often consist of scales that are similar to those used to assess racism; the OFS is intended to assess symbolic sexism, while the MS is intended to explain subtle forms of sexism (Sears, 1988; Swim et al., 1995; Swim & Cohen, 1997). They are based on aspects of theories of old-fashioned sexism and modern sexism. The complete items are shown in Table 5-5.3 below, which contains 5 OFS statements and 8 MS statements; participants are asked to mark the extent of their agreement with each of these statements. Although the two scales are significantly intercorrelated, they assess different aspects of sexism. The OFS is highly correlated with AWS (Swim et al., 1995; Swim & Cohen, 1997). Swim et al. (1995) found that the internal consistency of the OFS was 0.65-0.66, and that of the MS was 0.82-0.84. The OFS and MS are frequently used and are widely accepted psychometric tools (Smith & Epstein, 2010). Furthermore, based on newer approaches to assessing racism, Glick and Fiske (1996) developed the **Ambivalent Sexism Inventory (ASI)**, which is designed to measure two different forms of sexism: hostile and benevolent. The ASI has been shown to have good internal consistency and psychometric properties as a measure of sexism.

Table 4-4.2: The Modern Sexism Scale

	Scale	ITEM
Old-Fashioned Sexism		1. Women are generally not as smart as men. *
		2. I would be equally comfortable having a woman as a boss as a man.
		3. It is more important to encourage boys than to encourage girls to participate in athletics. *
		4. Women are just as capable of thinking logically as men.

		5. When both parents are employed and their child gets sick at school, the school should call the mother rather than the father. *
Modern Sexism	Denial of continuing discrimination	1. Discrimination against women is no longer a problem in the United States. *
		2. Women often miss out on good jobs due to sexual discrimination.
		3. It is rare to see women treated in a sexist manner on television. *
		4. On average, people in our society treat husbands and wives equally. *
		5. Society has reached the point where women and men have equal opportunities for achievement. *
	Antagonism toward women's demands	6. It is easy to understand the anger of women's groups in America. *
		7. It is easy to understand why women's groups are still concerned about societal limitations of women's opportunities.
	Resentment about special favours for women	8. Over the past few years, the government and news media have been showing more concern about the treatment of women than is warranted by women's actual experiences. *

The table was adapted from McConahay's (1986) Modern Racism Scale to illustrate comparative items assessing modern sexism.

Note: Items with an asterisk * required reverse scoring.

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These measures and scales are exclusively designed to assess gendered, sexist or alternatively feminist attitudes, especially regarding discrimination and prejudiced attitudes against women. The scales require respondents to rate their agreement with the statements for subsequent scoring. The scale I used in this research to assess explicit gender-STEM stereotypes was recently introduced by Jackson, Hillard, & Schneider (2014) to pre- and post-test the impact of diversity training. The WSTEM scale is intended to test explicit attitudes about women in STEM fields, which fits the aims of this research, i.e., to test women's explicit attitudes about women in STEM fields. In Jackson et al.'s (2014) study, the pre-test and post-test Cronbach's alpha were found to be .83 and .87. This scale will be discussed in greater depth in next chapter.

4.3.2 Measurement of Implicit Attitudes

All of the measurements discussed above are direct methods of assessing women's attitudes explicitly. Early social psychology research (e.g., Katz & Braly, 1933) employed these methods, which has since been developed many times to fit the purposes of subsequent studies. However, it is arguable whether these direct methods for measuring gender stereotypes are good enough for stereotype and prejudice researches (Nosek, Greenwald & Banaji, 2007). A shift toward less direct forms of measurement has been widely proposed by researchers in order to assess various aspects of implicit attitudes and define them more accurately. Inspired by the implicit theories from memory research (see Chapter Three), implicit methods were developed to measure implicit attitudes (e.g., IAT). The measurement methods used in social cognition were reviewed by Nosek, Hawkins, and Frazier (2011). The indirect methods here refer only to the implicit methods for measuring stereotypes I have discussed; other indirect methods that might be useful for other contexts in social cognition research will not be discussed here.

Compared to explicit measures, indirect measures differ in their (1) decreased response awareness, (2) lower intentionality, (3) decreased controllability, and (4) higher efficient processing (Bargh, 1994; Nosek, 2007). Indirect measures provide an assessment of an attitude without directly asking participants for a verbal report (Fazio & Olson, 2003). They require a participant to respond as quickly as possible to a stimulus word (or image). The limited time for reaction leaves a participant little attention space for rationalisation or extensive reflection on an attitude's content; therefore, such prompt responses rely on tacit knowledge and implicit opinions. Because of this, they are more rapid, automatic, spontaneous, intuitive, unconscious, and domain-specific (Evans, 2008). It is assumed that these indirect measures should be free from social desirability concerns (Fazio & Olson, 2003), which makes them especially appealing for social and clinical psychology. Response time and content are two significant variables of interest for researchers.

Indirect measures of attitude can be made through three methodologies: priming procedures, physiological indicators, and implicit association methods. A priming procedure exposes the participant to a prime (a word or a picture), which functions as an elicitor of an attitude, before then exposing them to a target figure, at which point a researcher measures the attitude. In implicit association methods, on the other hand, researchers remove the prime and instruct participants to provide correct categorical responses to the target figures presented (i.e., indicate to which category the target figure belongs by pressing a key).

Implicit association methods rely heavily on assessing how quickly certain target concepts can be attributed to specific attitudinal categories (e.g., “good” or “bad,” “pleasant” or “unpleasant”). Since the conception of the first implicit association method, the implicit association test (IAT) (Greenwald, McGhee, & Schwartz, 1998), researchers have developed many variations of this revolutionary method. These new methods of assessing implicit attitudes include the Single-Target Implicit Association Test (ST-IAT), the Single Category Implicit Association Test (SC-IAT) (Karpinski & Steinman, 2006), the Go/No-go Association Task (GNAT) (Nosek & Banaji, 2001), and Sorting Paired Features (SPF) (Bar-Anan, Nosek, & Vianello, 2009), all of which use reaction times as well as correct and incorrect responses to stimuli to assess implicit attitudes, such as various the holding of stereotypes and prejudices. By pairing different target figures (words or pictures) with different attitudinal terms or phrases, these measures can assess how quickly and accurately participants respond with a particular attitude to each of the target concepts.

4.3.3 Understanding the Relationship between Implicit and Explicit Attitudes

As a large body of research accumulated using implicit cognition and implicit methods, researchers began to consider the relationship between implicit and explicit attitudes. Studies have shown that the relationships between implicit and explicit attitudes might be various, and correlation coefficients may range from .27 to .56 (e.g., Fazio & Olson, 2003; Nosek, Greenwald, & Banaji, 2007). Social cognition theories might be applied to interpret the relationship between implicit and explicit attitudes, as discussed in Chapters Three and Four. The first theory or assumption is that these two processes are different ways of processing the attitudes; they predict two types of behaviours (e.g., Greenwald & Farnham, 2000; Cunningham, Preacher, & Banaji, 2001). For instance, based on this assumption, Nosek and Smyth (2007) predicted seven dominant attitudes measured with IAT and self-report. The results indicated that the combination of implicit and explicit methods to measure one dominant attitude is more powerful than a single measure to measure seven dominant attitudes separately. The study also found that although implicit and explicit measures assess related attitudes, they evaluate them based on two distinct attitude constructs. Another tool used to interpret the relationship between implicit and explicit attitudes is the MODE model (Fazio, 1990; Fazio & Towles-Schwen, 1999), a classic dual-process model (Chaiken & Trope, 1999). The MODE model assesses whether the two processes by which attitudes become behaviours are primarily spontaneous or deliberate in nature. A summary of dual-process theory is presented below.

4.3.3.1 Dual-Process Model

The Dual-Process Model interprets the differences between implicit and explicit measurements according to how individuals process information. This model is based on the assumption proposed by social and cognitive psychological research that human beings process information in two ways simultaneously (Evan & Stanovich, 2013). It has been applied in many types of multi-phase research to describe the two modes of cognitive processing. Evans (2008) divides the neutral processes into either "System 1" or "System 2" (see Table 3-5.1 below). The essential contents of each system are similar. Some researchers define these two different modes of cognitive information processing in terms of implicit and explicit systems (Reber, 1989; Forgas, Williams, & Von Hippel, 2003; Evans & Over, 2013). Evans (2008) summarises groups the attributions of these two systems into four categories (see Table 3-6.2). To distinguish between these two modes when applied to social cognition, it can be said that the former is characterised by being 'unconscious (preconscious), implicit, automatic, rapid, domain-specific, spontaneous, and intuitive,' (Karandashev & Evans, 2017), while the latter features "such attributes as being conscious, explicit, controlled, slow, domain-general, intention-based, and controlled' (Karandashev & Evans, 2017).The application of this system in attitude-behaviour research is discussed at length in Mayerl (2013). The *Tables 5-4.3* below summarise related words used to describe these two systems.

Table 5-4.3: Labels Attached to the Two Process in the Literature, Aligned on the Assumption of a Generic Dual-System Theory

References	**System 1**	**System 2**
Fodor (1983, 2001)	*Input modules*	*Higher cognition*
Schneider & Schiffrin (1977)	*Automatic*	*Controlled*
Epstein (1994); Epstein & Pacini (1999)	*Experiential*	*Rational*
Chaiken (1980), Chen & Chaiken (1999)	*Heuristic*	*Systematic*
Evans & Over (2013)	*Implicit/tacit*	*Explicit*
Evans (1989, 2006)	*Heuristic*	*Analytic*
Sloman (1996); Smith & DeCoster (2000)	*Associative*	*Rule based*
Hammond (1996)	*Intuitive*	*Analytic*
Stanovich (1999, 2005)	*System 1 (TASS)*	*System 2 (Analytic)*
Nisbett et al. (2001)	*Holistic*	*Analytic*
Wilson (2004)	*Adaptive unconscious*	*Conscious*
Lieberman (2003)	*Reflexive*	*Reflective*
Toates (2006)	*Stimulus bound*	*Higher order*
Strack & Deustch (2004)	*Impulsive*	*Reflective*

from (Evans, 2008)

In short, the dual-process model's implicit and explicit measurements could be used to assess stereotypes from different directions. As Fazio and Olson (2003) note, the implicit measures are not theoretical, but are more empirically driven methodologies. These two information-processing systems may not be discrete, but instead might operate in parallel and continually (Evan & Stanovich, 2013). The two above assumptions only offer interpretations to help us understand the relationship between these two different or related cognitive approaches. After the explicit sexism scales and implicit measures described above were developed, and the relationship between the two was studied, the emergence of a combination of implicit and explicit methods became possible. As the implicit methods are rarely compared with explicit scales, I also need to consider the validity and reliability of these as methods; the correlation between them will also be discussed below.

4.3.4 Validity and Reliability of Implicit Attitude Measurements

4.3.4.1 Validity

The validity of implicit methods has been supported by multiple studies. In particular, the validity and reliability of the priming procedures have been demonstrated through the series of studies by Fazio, Jackson, Dunton and Williams (1995) and Payne, Cheng, Govorun & Stewart (2005). Later, a comprehensive meta-analysis of 167 studies identified that the scores in sequential priming tasks significantly correlate to behavioural measures ($r = 0.28$) and explicit attitude measures ($r = 0.20$). These results are similar across domains and methodologies, indicating that sequential priming is a valid method for the study of social cognition (Cameron, Brown-Iannuzzi, & Payne, 2012).

The construct, convergent, and discriminant validity of implicit association methods have been confirmed in a number of studies. For instance, validity has been proven through correlations of responses to universally understood attitudes toward particular concepts (e.g., attitudes toward flowers as good compared to guns as bad) (Greenwald et al., 1998; Nosek, Greenwald, & Banaji, 2005). It has also been demonstrated through explicit self-report assessments and other implicit measures (Cunningham, Preacher, & Banaji, 2001; Bluemke & Friese, 2008; Bar-Anan et al., 2009).

4.3.4.2 The convergent validity of implicit methods

The validity of implicit measures of attitudes was supported via the convergence of their results with other measures for the same constructs. Despite various critiques of explicit self-report accounts in personality and social psychology, they are considered among the most valid measures of attitudes and a major source of scientific knowledge in the field. Therefore, the matching between implicit and explicit measures—in terms of high correlations and nonsignificant differences in t-tests between explicit and implicit scores—could indicate the validity of the former. In studies conducted by Nosek and colleagues, the validity of the IAT was supported through correlations between implicit and explicit attitudes in many constructs (Nosek, 2005, 2007; Nosek & Smyth, 2007). Correlations were within the range from small (below 0.20; e.g., Asians-Whites) to high (above 0.75; e.g., pro-choice-pro-life), with a median correlation of 0.48. The authors noted that a two-attitude model was a better fit than a single-attitude model in all domains, including those with high correlations (Nosek & Smyth, 2007). Thus, implicit and explicit attitude measures revealed the distinct constructs but were also related to each other.

4.3.4.3 Internal validity of implicit measures

Fazio et al. (1995, p. 1024) tested internal validity of the EPT through the impact of social desirability, or “motivation to control prejudice”, on the explicit racism scale and how the implicit priming procedure controls for this confound. In order to test this, Fazio et al. (1995) created a scale that assessed the participants’ motivation to control any prejudiced thoughts and behaviours and compared these results with those of the racism scale and the implicit priming procedure. The results showed that individuals who showed a higher motivation to control prejudice ranked low in prejudice on the explicit racism scale and showed more negative racial attitudes on the priming procedure. Additionally, those that showed lower motivation scores had similar explicit and implicit results.

4.3.4.4 The predictive validity of implicit methods

Research findings support the validity of implicit measures in terms of their ability to predict other external variables of social behaviour for priming methods and implicit attitudes methods (e.g., Greenwald & Nosek, 2001; Fazio & Olson, 2003; Nosek, Greenwald, & Banaji, 2007; Greenwald, Poehlman, Uhlmann, & Banaji, 2009). In particular, Fazio et al. (1995) found that automatically activated racial attitudes allowed the prediction of a black target's ratings of the quality of her interaction with the respondent. The participants, who were activated with negativity during a priming task, behaved in a less friendly manner during their later interaction with the Black target. These attitudes also correlated with how participants judged the likelihood that Blacks were deemed more responsible than Whites for the tension and riots that followed the verdict of not guilty regarding the police involved in the beating of Rodney King.

Fazio and Olson (2003) provide many other examples of research results and more complex patterns of findings that demonstrate the predictive validity of various types of priming. The IAT measures also predicted discrimination and explicit measures of prejudice. The implicit measures revealed various behaviours and corresponding relationships.The predictive validity of IAT was also supported by "known-group" effects, whereby two groups of participants obtained different IAT scores in an expected way. For instance, IAT indicated the presence of in-group preferences in several cultural samples (Greenwald et al., 1998; Rudman, Greenwald, Mellott, & Schwartz, 1999; Monteith, Voils & Ashburn-Nardo, 2001; Keuhnen et al., 2001). The "known-group" differences in IAT were also found in the studies on vegetarians and cigarette smokers, White versus Black participants, snake- and spider-phobic individuals, homosexuals and heterosexuals, in drink and food preferences, and in how people associate gender with mathematics (for a detailed review, see Greenwald & Nosek, 2001; Fazio & Olson, 2003). It is important to note that the IAT and priming procedures may predict judgments and behaviour moderated by motivational factors. Florack, Scarabis, and Bless (2001) found a moderating effect of the need for cognition on how the IAT measures of favourability toward Turks, relative to Germans, reflected on subsequent judgments of a Turkish juvenile delinquent. Opportunity, motivation, and process reliance also play a moderating role in how implicit measures predict behaviour (see Friese, Hofmann, & Schmitt, 2009). Thus, for future research on the predictive validity of implicit measures, it is important to consider motivational and moderating variables.

4.3.4.5 Reliability

Priming and implicit association methods provide less reliability than more direct (i.e., explicit) methods. Despite the inherent lower reliability, studies involving implicit association methods provide support for the methods' acceptable levels of reliability. This reliability comes in the form of internal consistency as well as test-retest reliability.

4.3.4.6 Internal consistency

Some studies have assessed the internal consistency of their measures across all items of their respective scales (Karpinski & Steinman, 2006; Bluemke & Friese, 2008). They have compared the consistency among two halves of all items (i.e., split-half reliability) (Nosek & Banaji, 2001), and have compared results among the items of different trials (Bar-Anan et al., 2009). Additionally, the results of the studies that utilised the AMP (Payne et al., 2005) revealed a high average of Cronbach's alpha of 0.88.

4.3.5 The Correlation between Implicit and Explicit Methods

The findings of previous studies reveal correlations between implicit and explicit variables. Priming methods and implicit attitudes tests have demonstrated a correspondence with self-reported measures of attitudes toward mundane, socially noncontroversial objects (Fazio, Sanbonmatsu, Powell, & Kardes, 1986; Greenwald et al., 1998). Nosek, Banaji, and Greenwald (2002) reported fairly substantial correlations between IAT preference scores and self-reported preferences regarding maths versus arts. Correlated scores were also found for attitudes regarding the 2000 US presidential candidates Al Gore and George W. Bush. Some studies reported significant correlations between scores of implicit attitudes or priming methods with explicit variables in such social-sensitive domains as prejudice and stereotypes (e.g., Lepore & Brown, 1997; Wittenbrink, Judd, & Park, 1997; Kawakami, Dion, & Dovidio, 1998;

McConnell & Liebold, 2001). Fernández Quiroga, Escorial and Privado (2014) found gendered realities in the domestic sphere using both explicit and implicit measures. The data for the two types of measures showed conceptual similarity, even though they were obtained via procedurally different means. The speed of sorting items into categories in IAT correlated with the explicit attitudes being assessed in self-reports (Nosek, 2007; Nosek & Smyth, 2007).

In personally and socially sensitive domains, it is likely that motivational factors are evoked and exert some influence on overt responses in an explicit measure (Fazio & Olson, 2003). This can explain the results of several studies (Skowronski & Lawrence, 2001; Hofman, Gawronski, Gschwender, Le, & Schmitt, 2005; Devos, Blanco, Rico, & Dunn, 2008), which revealed inconsistencies or discrepancies between implicit and explicit methods employed in the research of gender roles.

In the study of self-esteem—a personally sensitive topic—IAT measures weakly correlate with standard explicit (self-report) measures. Testing the validity of IAT measures of gender self-concept using the known group approach, researchers found three times the differences in implicit femininity-masculinity scores between women and men compared with explicit measures (Greenwald & Farnham, 2000). Other researchers (Asendorpf, Banse, & Mücke, 2002) revealed a double dissociation between implicit and explicit personality self-concept for the case of shy behaviours.

Studies on socially sensitive topics of prejudice and stereotypes have often obtained quite low correlations (e.g., Fazio et al., 1995; Greenwald et al., 1998; Rudman & Kilianski, 2000; Kawakami & Dovidio, 2001; Monteith, Voils, & Ashburn-Nardo, 2001; Ottaway, Hayden, & Oakes, 2001; Devine, Plant, Amodio, Harmon-Jones, & Vance, 2002; Dovidio, Kawakami, & Gaertner, 2002). Possible explanations for the low correlations between results obtained with implicit and explicit measures of such personally and socially sensitive topics include: (1) the motivational bias that participants may express in their explicit self-reports; (2) the limited introspective access of participants to their implicit representations of attitudes; (3) problems with the retrieval of information from memory; (4) characteristics of the two measures related to their methods; or (5) that they measure independent underlying constructs (Hofman et al., 2005). The growing evidence has demonstrated that implicit measures bring valuable knowledge that is distinct from self-report scales, and thus they may be free from the limitations of introspective explicit measurements (Wilson & Brekke, 1994; Nosek, Hawkins & Frazier, 2011).

The validity of implicit methods has also been supported by studies that were able to detect faked responses to account for social desirability (Karpinski & Steinman, 2006; Cvencek, Greenwald, Brown, Gray, & Snowden, 2010). In order to detect faked responses in future studies, the researchers instructed their participants to fake their responses. For example, Cvencek et al. (2010) instructed their participants to purposefully slow their reaction times to the stimuli that were presented. From this, they were able to develop a combined task slowing (CTS) index, which was able to detect faked responses and genuine responses with a mean 75% accuracy. In the case of Karpinski and Steinman (2006), after analysing the results of the participants who had been instructed to fake their responses, they noticed that these participants had markedly high error rates in their responses.

Researchers found that both implicit and explicit aspects of the self-concept of personality allow for the prediction of actual behaviour, including in many relevant social situations and behavioural indicators. In particular, direct measures (questionnaires) of personality predicted actual behaviour for all of the “Big Five” dimensions, while indirect measures (implicit association tests) of neuroticism and extraversion also predicted actual behaviour (Back, Schmukle & Egloff, 2009). The meta-analysis of multiple research reports found that the IAT moderately ($r = 0.274$) predicted judgment, behavioural, and physiological variables. Parallel explicit self-report measures also demonstrated predictive validity ($r = 0.361$), but with higher variability of effect size. For socially sensitive topics, the predictive validity of self-report measures was lower since participants might distort their self-report responses to make the desired impression (Greenwald et al., 2009).

All these results have demonstrated that implicit assessments converge with explicit ones. Generally, the high correlations between implicit and explicit measures are observed in the domains of socially and morally neutral or mundane themes, while low correlations are observed in relation to socially sensitive issues. Some studies (cited above) constitute exceptions in this regard. As this research discusses socially sensitive topics, the correlation between implicit and explicit might be lower.

To sum up, this chapter has thus far discussed the overall sequential mixed-methods approach of the thesis, and more specifically the implicit and explicit methods used to assess stereotypes and prejudice in the quantitative phase, and how they are applied in real-world research. Both implicit and explicit methods are valid, reliable and arguable measures of stereotypes, but they are complementary. In the literature, I have found that the correlation between the two kinds of methods might be lower when related to socially sensitive topics; however, this might demonstrate the different assumptions involved in measuring implicit and explicit attitudes or when interpreting topics from different cognitive perspectives. In this sense, when implicit and explicit methods were used at the same time, they were explanatory and predictive. This is why both forms are used in this research. A specific measure called the Implicit Association Task (IAT) is used in this research to detect implicit gender-STEM stereotypes through the automatic associations individuals make between STEM attributes and gender. As has been discussed in this chapter, the validity and reliability are decent when using IAT to measure implicit stereotypes (Bar-Anan et al., 2009), and significant correlation is found when combining IAT with explicit scale measurement (Lepore & Brown, 1997; Wittenbrink et al., 1997; Kawakami et al., 1998; McConnell & Liebold, 2001).

However, when explicit and implicit measurements are both applied to prejudice and stereotypes, the correlation might be lower. The possible reasons for this might be that the beliefs are either too personal and sensitive to be measured given the limitations to access implicit and explicit measurements (Fazio et al., 1995; Greenwald et al., 1998; Rudman & Kilianski, 2000; Kawakami & Dovidio, 2001; Monteith et al., 2001; Ottaway et al., 2001; Devine et al., 2002; Dovidio et al., 2002), or they are just not similar constructs (Hofman et al., 2005). Thus, the use of implicit and explicit measurement (e.g., IAT and sexual scales) in this research might not be theoretically supported, but more empirically driven (Fazio & Olson, 2003). The details of the IAT and the explicit methods used in this research will be presented in Chapter Five, however, this chapter will now lay out the epistemological and ontological underpinnings for the qualitative phases of study.

4.4 Reliability, Validity Trustworthiness and Rigour in Qualitative Phase

The reliability of qualitative methods is widely discussed in the literature (e.g., Mays & Pope, 1995; Mays & Pope, 2000; Barbour, 2001; Golafshani, 2015). Stenbacka (2001) argues that since reliability issues concern measurements, they have no relevance to qualitative research. She adds that the issue of reliability is an irrelevant matter in judging the quality of qualitative research. Therefore, if it is used, then the ‘consequence is rather that the study is no good’ (p. 552). To widen the spectrum of the conceptualisation of reliability and reveal the congruence of reliability and validity in qualitative research, Lincoln and Guba (1985) state, ‘Since there can be no validity without reliability, a demonstration of the former [validity] is sufficient to establish the latter [reliabilitby]’ (p. 316). Patton (2002) with regard to the researcher's ability and skill in any qualitative research also states that reliability is a consequence of the validity of a study. Thus, it is hard to measure validity as a result of reliability in qualitative research. Nevertheless, techniques such as triangulation have been suggested as ways in which the researcher can improve the validity of their research (Mays & Pope, 2000). But the nature of qualitative research leads to no standard solutions for the rigour of the question (Mays & Pope, 2000; Barbour, 2001); qualitative research could not, and should not, follow certain rules to ensure rigour in each piece of research. Instead, rigour within qualitative research may be assessed with regard for the richness of the data and its ability to address the research question(s) at hand, and it is essential to ensure that the research is scientifically valid. Therefore, the concepts of trustworthiness, subjectivity and reflexivity will now be considered with regard to qualitative rigour in this phase of study.

4.4.1 Trustworthiness

It is suggested to provide rigour in qualitative research across the research and design (Morrow, 2005), and is achieved through several potential aspects. *Social validity* has been posed as a *Standard of Trustworthiness,* raised by Wolf (1978) when discussing the issue of subjectivity, for instance social value as seen in the applied analysis of his own behaviour research. He argued whether 'fuzzy subjective criteria' and altered 'naturalness' may negated the more valuable needs of meeting social validity in qualitative research, that can better be met through applied social values.

For instance, Morrow argued that the diversity and discrimination prevention underlying the principles of counselling psychology would do help with this justification of social validity- is the research inclusive and does it promote health-based solutions might for instance be the metrics by which his research is then valued. In the present research, in line with BPS ethics and educational duties, some trustworthiness metrics of the present phase might include the need to better meet learner needs for inclusion and belonging, to hear diverse voices and to ensure that their stories are not only told but feed into university policy and practice moving forward. In a practical sense this trustworthiness must take place in the data collection, transcription, coding.

Qualitative researchers try to find the very nature of the data and the analytic process I engaged are embraced in *Subjectivity and Reflexivity in Qualitative Research,* which relates to how I as researchers might manage, limit, control and/ or simply address the subjectivity of our approach, and this is highly relevant to researcher themselves, as these processes could be seen as either enriching or biasing the data and its interpretation (Morrow, 2005). Reflexibility is critical reflection on the research process as researcher (Finlay, 2002a, 2002b), including addressing various insider and outsider positions (Gallais, 2008). As researchers, I make assumptions with our work, and must acknowledge potential biases based on our cognitions. On the one hand, researchers could be aware of this and attempt to put implicit assumptions aside to avoid affecting the subjectivity of qualitative research (Husserl, 2012). On the other hand, this strategy for research would be impossible to achieve completely, so the acknowledgment of how the researcher engaged and occupied space in the qualitative research process is necessary.

Thus, the notion of qualitative research can be seen as a collection of 'the researcher's emotional involvement with the topic of interest, presuppositions formed from reading the literature, and various aspects of interaction with research participants' (Morrow, 2005. p 254). Glaser, Strauss and Strutzel (1968) argued that researcher should at least avoiding the depth of engagement of literature investigating. Recent researcher doubted that engagement with grounded literature could mitigate against researcher's bias, as it instead sllows through multiple aspects and understandings of the same issue (Levitt, Motulsky, Wertz, Morrow & Ponterotto, 2017; Fassinger & Morrow, 2013; Morrow, 2005). Practically within this research, my subjectivity is address with consciously self-reflection. And furthermore, reflexivity is presented my own impact on this research (see next section below) My embeddedness within the work as a Chinese researcher studying STEM affords me the insider views of understanding with participants, in terms of deeper interpretation of data (also see section 7.2).

Therefore, in this study, qualitative *rigour* was addressed by steps toward trustworthiness and a balance of subjectivity with reflexivity as above, but furthermore via the triangulation of findings that were applied in multiple ways via multiple methods used, such as, focus groups and interviews, leading to more valid, reliable and varied pathways to understand realities in the qualitative phases; to improve the analysis and understanding of the data, I followed the suggestion of Johnson (1997) to 'use investigator triangulation and consider the ideas and explanations generated by additional researchers studying the research participants' (p.284). Through the whole process, I had discussions of the transcripts and coding with my supervisors and colleagues. I discussed, for instance, different languages used in the analysis in different levels of analysis. The triangulation of the quantitative and qualitative findings, as well as the triangulation of two phases of qualitative data collection (focus groups and interview phases) with their two separate methods of data analysis (thematic analysis and interpretative phenomenon analysis respectively) provide greater real-world validity to ensure these data address the overarching aims of the thesis. Additionally, this phase of qualitative study as part of a sequential explanation mixed-method design also shared the validity of the whole research design.

4.4.2 Researcher's own impact on Qualitive research (Reflexivity)

Researcher's positionality in the qualitative research is expected to 'self-awareness and agency with that self-awareness' (Rennie, 2004. p.183), which requires reflexivity on one's role in the research, and endeavours for the researcher to address explicitly assumptions from their own life experiences' which may both bias and enrich their approach to data collection and analysis. Reflexivity, in other words deep self-reflection and application to one's research approach, is one of the most efficient ways to balance subjectivity. I did this by keeping a self-reflective journal during the whole research process. The journal records the experience, reaction to the process of this research, will bring any self-reflective assumptions from self-bias to conscious levels. Also, it's a process and collection of self-understanding and alert to certain extent when applied to data analysis and interpretations. It should be acknowledged that it's natural that the researcher holds interests and knowledge about Gender-STEM stereotypes being a woman myself in STEM fields, I wish personally to uncover the effect factors and underlying reasons affecting my colleagues and myself. Therefore, the questions, the design and discussions to some extent might be aligned and driven by those underlying reasons and interests, and I see this as a genuine strength of the research.

In my research, from the beginning of research interests to the end of interpretations of data, I always hold both an insider and outsider position, depending on the research frames, the stage of the research, and also depending on the topic of discussion in data analysis. However, Bryman and Burgess (1994) argue that it is impossible to ascertain that any assumption or previous research is completely omitted from the entire analytical procedure. In this respect, I agree that researchers cannot fully free themselves of the theoretical and epistemological viewpoints that they already had in their minds. However, starting analytical work in an inductive way is not to guarantee that presuppositions are eliminated at any stage of the analysis; rather, it is an attempt to give voice to the participants as a starting point. The integration of the quantitative findings and previous literature will come at a later stage of the analytical process as an important part that constitutes the development of the conceptual framework. Although the interview schedule is structured based on quantitative findings and existing literature, from another angle, it can be argued that inductive analysis enriches the holistic understanding of the topic in the light of new issues arising out of the data, which helps generate a new conception. And this is how I approached the start of this qualitative phase of study, with an informed yet open approach to the data collection and findings.

Once the focus groups and interview data were collected, they were transcribed. Bazeley (2013) describes the process of transcription as a good starting point for familiarising oneself with the data, though it may be time-consuming and sometimes tedious. This conforms with Braun and Clarke's (2013) view that the time invested in transcription is not wasted, as it not only uncovers the first stage of the qualitative analysis, but also offers the opportunity for the researcher to familiarise themselves with the data. This is particularly true regarding the time spent checking the transcripts against the original audio recordings for fluency and accuracy. Similarly, according to Lapadat and Lindsay (1999), transcribing can be viewed as an interpretative act, in that the meaning is automatically created in the process of transcribing. The transcription was carried out manually into a Microsoft Word document. For the Chinese transcriptions, I only translated the quotes used to analyse and check with three Chinese-English speakers.

Trustworthiness of the interviews was endeavoured by making it aware to the participants that this research would by no means judge or assess their professional performance, and through building up trusted relationships between the researcher and the researched. Their perspectives about gender and their practitioners were reflected in their answers, providing interesting and useful data for this research. Many of those answers coincided with data collected through observations and practitioners' interviews too, hence are considered to be trustworthy. However, upon critical reflections I am also aware that the research findings should be analysed in manners that take into account several considerations. Overall, this research adopted a reflective approach in minimising the disadvantages of chosen methods and in solving problems that emerged during the research process. Some issues were unavoidable and were therefore made transparent in this chapter, especially those relating specifically to research with women in STEM fields.

4.5 Research Overview

The following section will introduce the overall theoretical framework inspired by current approaches and theories and the gaps in understanding women in STEM fields. This will be followed by the research aims and questions in the different phases. Figure1- 1.1 (see in chapter one provides an outline of the theoretical framework.

Women's underrepresentation in science or in other male-dominated areas remains a global issue. However, the developments that have taken place over several decades in some countries have shown that the gaps in STEM fields tend to close in primary education (OECD, 2018). Multiple attempts have been made by psychologists to explore and interpret women's underrepresentation in STEM fields. The cognitive explanation was that it was a matter of mathematical ability, with some researchers summarising STEM fields as maths-intensive (e.g., Else-Quest et al., 2010; Picho et al., 2013). Most of these studies concluded that it was females' lower mathematical abilities and performances that were the reasons why girls did not choose STEM fields (e.g., Cohen, 1988). While differences do exist in terms of mathematical cognitive abilities, it is not because of gender differences, and improvements could be achieved with training (Vasta, Knott, 1996; Quaiser-Pohl, Geiser & Lehmann, 2006). Also, girls' mathematical interests and performances might be affected by gender stereotypes regarding their abilities, even their math scores are overt than boys (Gunderson et al., 2012). Moreover, it has been found that when exposed to gender-math stereotypes, girls' math scores tend to be inferior to those of boys (e.g., Hattie, 2012). Even when women are gifted with maths ability, they still tend to choose non- STEM fields (Park et al., 2007). Maths ability is an indicator of girls' STEM interests, and gender-math stereotypes might affect girls' maths interests and performances.

Other factors might also impair the chances of women in STEM fields. As mentioned above, family and parents play a vital role in girls establishing gender roles. Furthermore, parents and teachers' gender-science stereotypic beliefs and expectations might impact on their science interests and future science-related career prospects (Fennema et al., 1990; Keller, 2001; Tenenbaum & Leaper, 2002; Chalabaev et al., 2009). Positive female role models in science will help to foster interest in science among girls, as well as their aspirations and chances of entering STEM fields (Scherer et al., 1989; Morgen et al., 2015). Moreover, exposure to female role models in STEM fields could serve to reduce the negative impact of gender stereotypes (Mclntyre et al., 2010). When professional female role models are presented in certain fields, women can build more confidence in those fields (Shin et al., 2016). However, females still encounter obstacles and barriers as science professionals which lead to girls wishing to avoid such difficulties and perhaps not choosing STEM fields (Smith et al., 2013).

All of the factors discussed above play a part in decreasing the chances of women entering STEM fields that feature gender stereotypic beliefs and expectations. This might impair women's interest in science, resulting in lower interest in careers in STEM fields. Women's own interests in careers could be related more than those impacts, but somehow still highly relevant to gender stereotypes (e.g., job segregation for women). Women tend to do work in professions deemed beneficial for society (Ceci, Williams & Thompson, 2011; Freund et al., 2013). Even in STEM fields, women's career goals are driven primarily by communal goals rather than agentic goals from the goal congruity perspective (Diekman et al., 2011).

The issue of women’s underrepresentation in STEM fields has been addressed in China as well, particularly, Chinese women's “leaky pipeline” in STEM higher education and careers. First of all, little Chinese research focuses on women in STEM fields from social cognition perspectives. Implicit and explicit gender stereotypes are generally found among Chinese high school and college students (Wei & Chen, 2005; Zuo & Liu, 2006). There is little discussion of the relationship or connection between explicit and implicit gender stereotypes and the underlying influencing factors, and there is a lack of data to support such inquiries. Also, there are no clear explanations of the processes of gender socialisation or the processes by which stereotyping factors influence gendered beliefs. Similarly, there is limited discussion of how these gender stereotypes subsequently impact women's STEM careers as a whole. A few studies have attempted to explain women's underrepresentation in STEM fields by analysing the whole process of Chinese women's gender socialisation and the formation of stereotypes. Besides considering social cognition, social or educational explanations, this research will attempt to understand the entire development process by employing a combination of social psychological and cross-cultural explanations.

Faced with women's underrepresentation in STEM fields, the UK undertook interventions earlier and more decisively than China did. The UK experienced similar issues regarding women in STEM fields, with girls tending not to choose STEM subjects as majors and as career goals. Moreover, UK women in STEM fields tend to leave the field. The situation appears to have improved greatly in the UK in recent decades. Nevertheless, some unsolved gender equality questions remain at the higher levels of STEM education and careers. China faces the issues but on a larger scale. Therefore, China aims to learn something useful from the UK's improvements and understand how women can achieve success in STEM fields so as to be able to implement positive change. In this study, I shall consider the issue based on Chinese norms and culture, but with the contribution of UK perspectives. Furthermore, when considering the same situation of the "leaky pipeline" in higher education in STEM subjects, women from both countries studying as postgraduate researchers in such fields can contribute cross-cultural views.

Most attempts to study the phenomenon have posed the question of why women are not to be found in STEM fields. While this approach could help understand and improve women's underrepresentation, it cannot answer the question entirely. Even if all of the necessary interventions were applied and the disadvantages faced by girls were addressed, female students might still decide to leave these fields (the "leaky pipeline"). Few studies have focused on the other side of the issue, that is, how can women enter and stay in these fields? In order to understand the situation, it might be helpful to consider how women can enter the field; however, we might reach more enlightening answers by considering how they can remain and persist in STEM fields than by considering why females are not present in these gender-STEM stereotypic environments.

No research has thus far explained the relationship between implicit and explicit gender-STEM stereotypes focusing on UK and China-based university (college) students. What little research there is on UK and China suggests that no major cultural differences exist regarding women's attitudes towards STEM subjects (e.g., they both think women are not good at maths and computers). However, there is a significant difference in attitudes towards women's maths ability, which comes from parents and teachers: Chinese women believe that their parents and teachers have lower expectations of them than of men (Forgasz et al., 2014), and women in engineering tend to have weaker implicit gender-math stereotypes than women in humanities (Smeding, 2012). Moreover, traditional Chinese female gender roles impact on Chinese women.

Women do not only hold gender stereotypes, but they also experience them in society. It is a vicious circle of interaction for women: they form gender stereotypes influenced by the gender stereotypic beliefs in their environments when they are born; with these gender stereotypic roles, they continue to experience gender stereotypic threats in society, which serves to further entrench these gender stereotypic roles. To break the chain and find ways to improve women’s underrepresentation in STEM fields, I need to take steps to understand why women hold gender stereotypes and why women experience gender stereotypes. This consideration is central to guiding the research design.

Since the development of feminism and concerns about gender inequality, previous research suggests that UK women have developed greater overt gender equality in STEM-related education and careers compared with Chinese women; however, UK women still suffer the impact of gender-STEM stereotypes. Leaky pipelines are still found at high-level educations and careers both in the UK and China. Both countries shared quite similar experiences of how gender-science stereotypes impact on women, albeit with cultural differences. Few studies have focused on women who succeed in STEM fields, who could provide lessons in how to remain in those fields. This requires understanding both the formation and the experiences of gender-STEM stereotypes. There is also a lack of research examining Chinese and UK cultural differences in gender-science stereotypes using implicit and explicit measurements, or studies exploring the underlying factors that may influence these beliefs.

Therefore, the main aims of this study were 1) Guided by social cognition theories, to identify implicit and explicit gender-STEM stereotypes and the possible impacts of gender stereotypes to detect how women develop gender-STEM stereotypes and understand the reasons for women's underrepresentation in STEM fields in the UK and China; The research also aims to identify the key influencing factors and inform the study's next phase. 2) use social identity theory to further explain gender-STEM stereotypes and experiences of gender-STEM stereotypes. Moreover, the study aims to explore how women achieve success at high levels of education (PhD) in STEM fields considering cultural differences in both countries. 3) Based on the above aims and results, to take a cross-cultural perspective to interpret and summarise patterns of Chinese women who succeed in STEM fields and offer suggestions and advice.

4.6 Hypotheses and Aims

Therefore, the main aim of the quantitative phase 1 of the thesis was to 1) guided by social cognition theories, identify implicit and explicit gender-STEM stereotypes and the possible impacts of such internalised gender stereotypes on women's underrepresentation in STEM fields in the UK and China; The research then aimed in the qualitative phase to 2) use SIT (Turner, Brown & Tajfel, 1979) as a lens to further explore experiences of gender-STEM stereotype development and barriers for women who have achieved success at the highest levels of Higher Education (namely researching PhDs) in STEM fields, with focus groups considering cultural differences in both countries (see overarching aim 2 below). The final aim in the second half of the qualitative phase of the thesis was based on the above aims and results to 3) explore in-depth the phenomenological lived experiences of Chinese women working successfully in their chosen STEM fields in the UK (see overarching aim 3 below). The triangulated discussion then aimed to accomplish the overarching aims. 4) Take a cross-cultural perspective to interpret and summarise patterns of STEM participation for British and Chinese women, critically applying the ‘leaky pipeline’ analogy, to explore the trajectories of women who succeed in STEM fields and the facilitators to overcoming barriers at key transition points for women studying and working in STEM from the UK and China.

4.6.1 Phase One: Quantitative Research Hypotheses

Overarching aim 1: identify implicit and explicit gender-STEM stereotypes and possible factors that might influenced women between the UK and China, especially investigate the Chinese group.

1. With the impact of Confucianism, traditional culture social trend and contemporary top-down women policy in China, Chinese students in STEM fields, regardless of subject of study would hold greater implicit and explicit gender-STEM stereotypes than female students from the UK.
2. Women in STEM fields will hold stronger implicit and explicit gender-STEM stereotypes, compared with women in non-STEM fields.
3. There will be an interaction between nationality and subject of study on explicit and implicit attitudes.
4. There will be a planned comparison with the Chinese participant sample, whereby Chinese women studying STEM will hold weaker gender-STEM stereotypes on implicit and explicit measures than their non-STEM counterparts
5. Implicit and explicit gender-STEM stereotypes will be positively correlated for the sample.

4.6.2 Phase Two: Qualitative Research Questions

Overarching aim 2: explore additional which factors positively influenced women’s decisions to study STEM leading up to their postgraduate studies in the UK, and identify the key facilitators, barriers and transition points that retained both UK and Chinese women’s progression in STEM at the postgraduate level and beyond?

Focus Group aims

1. To uncover the perceptions of women studying STEM Ph.Ds. regarding gender-science stereotypes.
2. To explore the challenges and barriers that women in STEM encounter along their career paths.
3. To explore what factors influence women's decisions to pursue a career in STEM (e.g. parents, role models).
4. To develop further ideas for research.

Interview aims (including focus group aims)

Overarching aim 3: Investigate in-depth the underlying factors influencing Chinese women's decisions to pursue and maintain in high-level STEM careers in the UK, considering wider cultural and family influence on career progression and maintenance?

1. To uncover the specific experiences/characteristics that inspire Chinese women to pursue and maintain careers in STEM.
2. To uncover the nationality-based differences between the experiences of successful female STEM researchers.
3. To develop further ideas for research.

5. CHAPTER FIVE: PHASE ONE QUANTITATIVE STUDY 1-IMPLICIT AND EXPLICIT STEM STEREOTYPES & ATTITUDE FOR BRITISH AND CHINESE WOMNEN IN HE

5.1 Research Design Overview

This chapter present the quantitative study 2 in full, including the methodology specific to this phase of data collection, as well as the findings and discussion of implicit and explicit gender-STEM stereotypes and attitudes for a chorot of British and Chinese women, some studying STEM and some not, at university in the UK. Research suggests that even people who claim not to have gender stereotypes may still hold implicit beliefs about women's gender roles related to working in STEM fields (Olson & Fazio, 2014). These implicit beliefs could impact an individual's choice of subject to study during higher education, and subsequently their choice of occupation (e.g., Preves & Mortimer, 2013). The central premise of this study was to explore British and Chinese women's attitudes towards females in STEM fields. This question has received few examinations in the literature, as seen in Chapter Three, it requires further empirical study, particularly in the Chinese group. The current study uses an online implicit association task to assess women's implicit stereotypes about women in STEM fields. Both UK and Chinese university students were invited to participate so that a comparison could be made across the two groups. Also, it should be noted that after the lab-based study (completed on a computer within a computer lab on the University of Glasgow campus), a focus group interview was conducted with a subset of participants, to provide a richer exploration of the participants' attitudes about gender stereotypes.

The first stage of this research involved a 2 (UK & China) *2 (STEM & non-STEM) designed IAT and a follow-up STEM attitude questionnaire. The purpose of this stage was to explore the attitudes towards women in STEM that were prevalent among females of the two countries. 166 female students from the University of Glasgow took part in this test, and valid data from 113 of them were ultimately collected. This phase of the research consisted of quantitative studies that looked at statistical relationships between British and Chinese female students studying STEM subjects and British and Chinese female students studying non-STEM subjects. The overarching aims for this phase is to identify implicit and explicit gender-STEM stereotypes and possible factors that might influence women between the UK and China. Specifically, overall phase one hypotheses as follows:

H1: Chinese female students in STEM fields, hold greater implicit and explicit gender-STEM stereotypes than female students from the UK.

H2: Women in STEM fields will hold stronger implicit and explicit gender-STEM stereotypes, compared with women in non-STEM fields.

H3: There will be an interaction between nationality and subject of study on implicit and explicit attitudes.

H4: There will be a planned comparison with the Chinese participant sample, whereby Chinese women studying STEM will hold weaker gender-STEM stereotypes on implicit and explicit measures than their non-STEM counterparts.

H5: Implicit and explicit gender-STEM stereotypes will be positively correlated for the sample.

For Study 1a, explore the implicit attitude Implicit Association Task (IAT) was used to explore implicit gender- science stereotypes. For Study 1b, it’s a following questionnaire (see Appendix 3) after IAT. The purpose of this survey was to collect demographic information and incorporate several relevant control factors, including explicit stereotype scales; these are very common in IAT testing. According to hypotheses, several main analyses were carried: two-way ANOVA, correlations and planned comparison (T-test) for Chinese group. In the next section, the procedure for designing and presenting the IAT and questionnaire will be explained.

5.2 Measures and Materials

5.2.1 Method Used in Study 1a. IAT

5.2.1.1 Word Pilot for IAT

The original gender-science IAT (Nosek, Banaji & Greenwald, 2002) was designed to be web-based and for a large population of participants. Several changes were made for this study to make sure it was both up-to-date and suitable. Each category contains 12 words, with the same 6 words being used for both the female and male group (see *Table 8-5.1* below for details). After the word pilot, each group was given an even number of 6 words, rather than the 6 or 7 words given in the original gender-science IAT.

The word category titles changed from "Science vs. Liberal Arts" to "Science vs. Humanities". The purpose of this study was to learn out about implicit stereotypes regarding STEM subjects. The other word category titles were not related to STEM subjects, which was introduced in chapter 5. The term "Liberal Arts" might have caused confusion to the participants in this test. 'Academic areas that are associated with the term "liberal arts" include: arts (fine arts, performing art, music, literature); mathematics; natural sciences (biology, chemistry, physics, astronomy, earth science); philosophy; religious studies; social sciences (anthropology, economics, geography, history, jurisprudence, linguistics, political science, psychology, sociology)'. The content of liberal arts is very broad and always refers to a degree. It is evident that some areas of liberal arts overlap with STEM-related subjects (e.g., social sciences, natural sciences and mathematics). The term "humanities" is more specific in terms of its content. Moreover, in this research, "humanities" here refer to the opposite of "STEM" (e.g., "non-STEM"), however, we could not show non-STEM as cues on the display might cause more confusions and lead to longer reaction time.

Therefore, the words used in this IAT were changed for this very reason. New areas of study have emerged to enrich people's lives, such as psychology, accounting and computer science. Firstly, we designed two questionnaires in two different languages (Chinese and English)[8]. The main purpose of the questionnaires was to learn about people's explicit attitudes toward masculine and feminine when they encountered gender and subject words. These questionnaires included a Likert-type scale, which is a widely used test for measuring attitudes directly. A 4-level rating system was used, with respondents asked to write a number from one to four to indicate whether a word was very feminine, slightly feminine, slightly masculine or very masculine. There was no neutral option provided so as to make sure the respondents could categorise these words into two different groups.

Firstly, gender words and discipline words were piloted in two questionnaires (see Appendix 2). New words (accounting, computer science, medicine, psychology and sociology) were added to the discipline questionnaire to make sure it was up-to-date. Accounting and computer science were popular majors among the students due to the market opportunities they offer. This consideration was important to bear in mind. The questionnaires were distributed randomly to 40 volunteers on the campus, with no gender or age requirements. Ten individuals completed each questionnaire. There were 20 Chinese and 20 British participants. Once completed, the questionnaires were handed back immediately in person.

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[8] Translations in Chinese and English were offered for all IAT content (word lists and instructions), questionnaires, and the transcripts of the Chinese focus group. The translations are considered to be as close to one another as possible. Three Chinese native speakers who were also fluent English speakers and were familiar with academic English usage were invited to assist this study by checking the translations. They did their best to make sure all translations in Chinese and English expressed the same contents. Different cultural connotations were also taken into account.

5.2.1.2 Results of IAT stimuli words pilot

The collected data was processed using the SPSS statistical analysis tool). In order to generate descriptive statistics, the M value and SD were analysed for each word. Though the sample size was small, the significant *p* value of the t-test was calculated as a reference. In the first gender words questionnaire, the word “Grandma” showed the highest M value (almost 2.0) in both national groups. This means that “Grandma” was not to be considered such a high feminine word for now. “Boy” had the lowest score (M value was very close to 3.0) among male words for the two groups. This means that “Grandma” and “Boy” were not showing obvious gender direction, removed from gender words category.

Opposing results were obtained for the subject words “Biology” and “Psychology” across the two nations in the pilot. “Biology” was found to be highly masculine (above 3.0) in the Chinese group, while it was found to be slightly feminine (almost 2.0) in the UK group. “Psychology” was slightly masculine (between 2.5 and 3.0) among the Chinese, but more feminine for the UK participants (between 1.5 and 2.0).

Table 6-5.1: Original Word Lists Used in Gender-Science IAT

Female	***Male***	***Humanities***	***Science***
Girl	Man	Arts	Math
Female	Male	Humanities	Chemistry
Women	Father	English	Physics
Daughter	Grandpa	Music	Engineering
Wife	Husband	Literature	Computer Science
Aunt	Uncle	Sociology	Biology
Grandma	Boy	History	Geology
		Philosophy	Astronomy

The Gender-science IAT word list can be found at this link: https://implicit.harvard.edu/implicit/iatdetails.html

5.2.1.3 IAT Procedure

The Implicit Association Test (IAT) is based on response latency and consists of a computer-based test that aims to provide access to automatic associations between a bipolar target and a bipolar attribute concept. It measures the strength of associations between concepts and evaluations, which makes it suitable for this gender-science IAT study (see *Table 6-5.1* for words used for target and attribute concepts). This table shows what acute words were used in this IAT. The word lists were adapted from the Harvard Gender-Science IAT (2018) which is available online. A word pilot was run before the word lists were used in the test (see word pilot section for details).

IAT also incorporates the IAT effect, which is based on reaction time difference between two tasks which are used to classify categories using different response keys. By following the different instructions in each block, words in different categories are associated with specific keys in that block. In this test, the categories were genders and academic subjects. The “F” and “J” keys on the keyboard were used to respond. Instructions were given for each block to guide participants when responding to the different word associations.

5.2.1.4 IAT Stimulus, Trails and Blocks

The stimuli in this IAT were words in different categories. The stimuli were divided into two types of attributes and four groups. The stimuli were presented using the E-Prime 3.0 software. When one word appeared at random in the centre of the screen, the participants were required to categorise the word by pressing a response key (“F” or “L”), whereupon the word disappeared. There was no feedback for participants as to whether they had chosen the “right” or “wrong” answer. The categories were congruent or incongruent depending on the individuals. The response times for one stimulus in each block are presented in *Table 7-5.2*.

Trail is the primary component in most cognitive computer-based tests. In this study, 180 trails were conducted for each test. Each trail was made up of multiple types of stimuli and differed from one experiment to another. In this IAT test, the words appeared and disappeared one at a time - this represented one trail. Seeing trails in one block means that the computer randomly displayed each word one time from the chosen word groups, whereas, 24 trails meant that the computer randomly displayed each word twice (for the frequency details of each word, see *Table 8-5.3*). All category words in the instructions and all stimuli words were highlighted in blue (gender category) and green (subject category) to keep participants aware of these categories at all times (see Appendix 1 for all instructions in English and Chinese).

Table 7-5.2: Word (Stimuli) Lists Used in Gender-Science IAT

Female	***Male***	***Humanities***	***Science***
Girl	Man	Arts	Math
Female	Male	Humanities	Chemistry
Women	Father	English	Physics
Daughter	Grandpa	Music	Engineering
Wife	Husband	Literature	Computer Science
Aunt	Uncle	Sociology	Biology

One block consists of several trails, trails aggregating by certain meaning in one block. In a typical IAT, there were seven blocks. I used a typical IAT (see *Table 10-5.3* for blocks and numbers of trails). The respondents were required to categorise the images with the words and responses. Also, according to different stimuli combinations (congruent or incongruent to the individual) and study purposes, the blocks were divided into compatible and incompatible blocks. In this test, Block 3 and Block 4 were compatible (congruent). These blocks presented an easier combination of two stimuli for those participants who had a gender-science stereotype. The incompatible blocks (incongruent) (Block 6 and Block 7) were opposite pairings of stimuli combinations. This might present difficulties for those who held that stereotype. Seven blocks were running in a typical IAT, but only four blocks of data were used in the analysis. The first two and the fifth blocks are practice blocks, the purpose of which is to help the participants understand the test and become accustomed to reacting to matching words by pressing a key.

The sequence of blocks followed a pattern of going from easy to complex sorting tasks. The participants were asked to respond as quickly as possible. Compared with the opposite pairing words, a shorter latency time for associating certain words was expected when these two words were highly associated at an unconscious level. For instance, *Table 8-5.3* shows the sequence of trails and blocks that represented a typical IAT setting. This IAT started by training participants to become familiar with pressing the “F” key for humanities subject words and the “J” key for science subject words. In the following block, the “F” key corresponded to female words and the “J” key to male words. Block 3 and Block 4 were a combination of the two previous blocks and were harder than the practice ones. Also, real data were collected in these test blocks and were therefore used in the data analysis. The following block was once again a practice test, with a reverse pairing to Block 1. The science subject words were assigned to the “F” key and humanities subject words were assigned to the “J” key. The last two blocks were combination test blocks again; the participants were instructed to press the “F” key for female or science subject words and the “J” key for male or humanities words.

Table 8-5.3: Sequence of Trial Blocks in the Gender-Science IAT

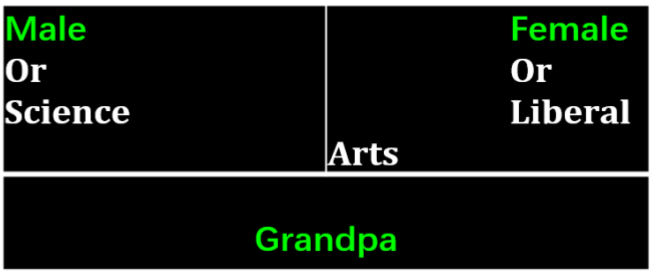
Block	No. of trials	Function	Words assigned to “F” key response	Words assigned to “J” key response
1	12	Practice	Humanities	Science
2	12	Practice	Female	Male
3	24	Test	Female or Humanities	Male or Science

4	48	Test	Female or Humanities	Male or Science
5	12	Practice	Science	Humanities
6	24	Test	Female or Science	Male or Humanities
7	48	Test	Female or Science	Male or Humanities

It should be noted that in Greenwald et al.'s original work, two different settings were used to avoid a sequence effect (Greenwald et al., 1998); for a more detailed discussion concerning the experimental variation of procedural variables, see Schnabel, Asendorpf, & Greenwald (2008). I only used one setting in this experiment, which Female &Humanities and Male & Science come first. These consistent (compatible) groups are much easier than when reacting to female & science and male & humanities subjects. The assumption here is that if people are much more familiar with a certain combination (they hold that stereotype), it would be easier for them to assign a value. Block 6 and Block 7 were much harder than the other setting because the participants had no chance to practise with them.

The screen display setting shown in *Figure 7-5.1* is an example of Block 3/4, where the category words of each block subject are displayed in the top left and top right corners of the screen. The category words remained the same throughout each block. After instructions were provided for each block, the stimulus words were randomly displayed in the centre of the screen.

Figure 7-5.1: IAT Display Example on Computer Screen in Block 3/4



Here, a black background was used to make it clear for the reader of this paper. However, In the actual test, the background was white. An instruction was be given before each block, e.g., Press "F" to classify as male or science, press "J" to classify as Female or Liberal Arts. Please respond as accurately and quickly as you can.' This instruction was shown before Block3/4 instructions and category word changes in the different blocks.

5.2.1.5 Display Different from Greenwald's

The original Gender-Science IAT displays male & science on the left side and female & humanities on the right side of the screen. When I try to read something, I tend to do so from left to the right. This might lead to a bias for the male and science categories in this case. Since in the original IAT, the male relevant group is always displayed on the left side of the screen, people notice them first. This impresses the reader in a certain way and makes these categorise stand out somewhat from the others. However, I wished to create a balanced or neutral set of options. Therefore, I changed the display settings, placing "Female" on the left side and "Male" on the other side. In this case, people might see them both at the same time when they are on the screen. It might not matter at all which side the words are displayed on.

5.2.2 Method used in study 1b. Questionnaire

A questionnaire was used after the test, as an explicit method to further explore women stereotype in STEM. To prevent the participants from knowing what I were testing for before the test, the questionnaire was completed after the IAT. This questionnaire was specially designed to elicit explicit attitudes about women in STEM and inspired by questionnaires in the journal of Jackson et al. (2014), which also focus on using explicit measurements to explore the implicit attitudes of women about association of women and STEM fields. Based on the purposes of this research, phase one aimed to know the explicit gender-STEM stereotypes between two countries by questionnaires, that informed the next sequential phase two; however, these gender-STEM beliefs might affect by many factors according to previous reviews (in chapter four). The relevant factors are family impacts (parents or guardians), role models, math ability and own interests to STEM subjects. I did not include teachers in the questionnaire, and assumed that families are universal than teachers, and the role model is an open question might overlap with teachers. To explore these factors and women's attitudes in questionnaires, I have several different attempts to reach them: favour beliefs for STEM subjects and women working in STEM fields, feeling thermometer, math scores and open questions about role models and parents. The last but not least, a five Likert Scale of implicit gender-STEM stereotypes (semantic differential items).

The contents of this questionnaire, which consisted of geographic information, explicit attitude rate towards STEM and art & humanities subjects, a feeling thermometer, questions about STEM, and a WSTEM Stereotype Scale (see Appendix 3). It should be noted that the questionnaire was only available in English. No translation was made so as to avoid providing misleading information. Translations should be used cautiously, as they might lead to cultural or other misunderstandings. This was not a time-limited task and an instructor was available to help at all times while answering the questionnaire.

5.2.2.1 Geography, favours beliefs and stereotype endorsement

The geographic information included nationality, fist language, gender, ethnicity, age, study major and study level. As taking the IAT previously might have been a factor that influenced the IAT effect, I asked participants if they had ever done an IAT before. The following questions were adapted from the original Gender-Science IAT. Besides the geographic information, explicit favour beliefs and stereotype endorsement to explore their interests of STEM fields from STEM subjects and women working in STEM fields were followed: The participants were asked to rate from 1 (Strongly dislike) to 5 (Strongly like) their attitude to STEM and art and humanities subjects. They were also asked to state how strongly they associated STEM and humanities and arts with females and males according to a scale (1-7), where 1 meant (strongly male) 4 meant (neither male nor female) and 7 meant (strongly female).

5.2.2.2 The feeling thermometer

The next section consisted of a feeling thermometer, which was originally designed for this questionnaire to reflect the participants' beliefs regarding women's occupations from both STEM and non-STEM groups. The feeling thermometer enables respondents to express their attitudes about a person, group, or issue by applying a numeric rating of their feelings toward that person, group, or issue, according to an imaginary scale. Using a feeling thermometer, respondents can express their feelings in terms of degrees, with their attitudes corresponding to temperatures (Millet, 2009). All of the relevant professional occupations I used were related to the disciplines used in the test. The participants had to rate their feelings about these female occupations from 0°*F* (very cold/unfavourable) to 100 °*F* (very warm/favourable). The unit used was Fahrenheit; but, in case some people were not familiar with this unit, the centigrade equivalent was marked alongside. The data was converted into Fahrenheit afterwards to compute from 0 to 100.

5.2.2.3 Parents in STEM

The participants were required to answer several open questions about their parents and themselves regarding whether growing experience affects their attitudes to women in STEM. Firstly, the questions referred to the participants' parents' (or guardians') education and whether or not they worked in STEM. These answers gave us insights into whether the participants' parents' STEM experience has an impact on their responses. Regarding the participants themselves, they were asked about their previous experience and whether they had a role model from a young age who had influenced their choice of career. Further, they were asked about their ideal occupations and their maths performance before they went to university.

5.2.2.4 WSTEM Scale

The last part of questionnaire incorporated the WSTEM Stereotype Likert- type Agreement Scales, which were tested by Jackson et al. (2014) (pre-test and post-test Cronbach's alpha were .83 and .87 separately). It was driven from semantic differential items from Olson and Fazio (2004) and adapted in Jackson et al. (2014). This was explicit attitudes towards STEM and art & humanities subjects, which indicated that women's belief about women in STEM fields and non-STEM fields (art & humanities). They completed the semantic differential items into three parts: "Stereotypes (based on list of stereotypes from Beyond Bias and Barriers (Singer, 2006))", "Favourability" and "Humanities". To be more specific, this was a Likert-type agreement scale (1-5) with 12 items (National Academy of Science, 2006). Furthermore, four items consisted of statements reflecting favourability and associations regarding men and women scientists. Six were filler items, with statements regarding the humanities and liberal arts. While this scale aimed to test attitudes towards women in STEM, the filler items were included to help disguise the purpose of the test. So, the questions in "Humanities" (filler items) were not included in the final scores.

5.3 Participants

5.3.1 Recruiting participants

Recruiting participants for the study was not an easy task. It was very time-consuming, too. I aimed to recruit more than 20 for each group. Therefore, I required at least eighty female participants at first. Moreover, my focus was on a wide range of academic subjects and national characteristics. I used several different strategies to achieve this recruitment. Firstly, I distributed flyers (see examples in Appendix 9, 10) on the campus street. On the opening day, I placed them on the noticeboard of the relevant departments and schools. This turned out to be very unproductive and inefficient. I only recruited 15 respondents this way, some of whom did not meet the recruitment requirements. Two weeks passed, and as I had to follow a very strict timeline, I embarked on a new strategy: recruiting directly from the campus. I began to stand outside the main campus and relevant schools and waited for potential participants to show up. At this stage, it was quite clear and easy to identify my potential participants – although, it was also sometimes disappointing. Additionally, I offered a 100- pound voucher to participants. I spent over four weeks recruiting participants from different schools, the library and the lab room. Finally, I had enough numbers for this stage of the study: 166 in total.

The participants were all students at the University of Glasgow. Approval for the study was given by the College of Social Sciences Research Ethics Committee (see Appendix 7 for approval letter). Some students were recruited in specific subject seminars or lecture classes. The participants were aged between 17-50 years old and came from all study levels. Finally, 166 participants took part in this lab-based study and completed the questionnaire afterwards. In order to recruit as many participants as possible, no specific gender was required at first. After data was collected (see next sections), only 113 participants' data was deemed valid for this study, including 55 students from the Chinese group (20 in STEM and 35 in non-STEM) and 58 students from the UK group (22 in STEM and 36 in non-STEM).

5.4 Procedure

The IAT test involves a series of stimuli and a reaction time measurement, which is a standard procedure in social psychology. The IAT method assesses implicit stereotypes by establishing how long a person takes to perceive and respond to a question by pressing keys on the keyboard to pair different gendered individuals with different STEM and non-STEM subjects. Please note that a word pilot test is given before the task to make sure the content is up-to-date. All of the words used in the IAT test and the word pilot questionnaire are showed in the Appendix 3. The whole lab-based task took between 15 and 30 minutes (depending on how fast the subject reacted to the experiment and answered the questionnaire).

Firstly, all of the tests were taken in the middle of the day, so that the participants would be better able and motivated to concentrate. Before the participants came to the lab, they were made aware of the content of this study in the posters or flyers, as well as the duration of the test and the general tasks required of them. After they had agreed to participate, they were sent an information form by email. When they came into the lab, an instructor explained this again showing them the information form (PLS, see Appendix 6). Also, they were asked about their physical conditions and whether they were able to take the test that day. To make sure they fully understood and had no doubt about this study, they were asked to sign the consent form (see Appendix 7). They knew they could take a break or leave without needing to provide any reason at any time during the test. When the test began, each participant sat in a separate lab booth (study cubicle) or in a classroom with only one computer and a chair. These relatively isolated and quiet places were selected to minimise the effect of the surroundings on the participants' cognitive functions. The questionnaire would be filled in using paper and pencil after the test. The researcher was available to help throughout the whole test.

5.4.1 Effect of Trail Error on IAT

To minimise trail error, distractions or other influential factors, we used lab-based computer tests rather than an online test links (as is common practice when administering IATs nowadays), since online tests prevent the researcher from controlling the test environment. In online tests, the researcher cannot be aware of the respondents' test conditions, such as whether they are physically unwell or even tired. Also, as time is another influencing factor, tests should not be taken in the early morning or late at night. Respondents might also be affected by drinking alcohol or their emotional conditions. Further, some respondents might be multi-tasking when taking online tests, for example, by answering their phone. These situations would lead to unstable attention and thus a higher level of trail.

5.5 Ethical Considerations

All of the participants were students aged 18 or over. They were given the plain language statement in advance of the activities and informed that they were free to choose not to participate, and that, even after starting, they were free to withdraw at any time.

The study's data collection involved two components. First, a computer-based task was conducted in a computer lab along with the completion of a questionnaire. The task was based on a widely used and validated methodology called the Implicit Association Task (IAT). The researcher piloted the words used in the task to make sure they were appropriate. The questionnaire contained simple demographics and items taken from other validated surveys.

The second component of the study's data collection was a focus group. Careful consideration was taken to phrase the questions when they are presented. The themes were made clear to the participants in the PLS so they would attend the group already knowing what would be discussed. The researcher led the group to openly discuss the themes and the participants could decide whether or not to answer. They were offered refreshments and breaks to minimise stress during the discussions. The participants were allowed to quit the focus group at any time without the need to provide a reason.

All lab-based activities and the focus groups were held in confidential locations on the University of Glasgow campus, including in computer labs and study rooms. Usual measures to ensure health and safety were followed in accordance with university policies. In the unlikely event that a participant felt any distress over the tasks or when discussing the issue of stereotypes, they could stop participating at any time and the university's counselling service was made available.

All data were stored confidentially and securely, and no personally identifying information was stored with the research data. The data held from these activities was password-protected and stored in secure locations. Upon receiving all of the data, the personally identifying information was removed and stored separately and deleted at the end of the study. Any quotes used from the focus groups were attributed to pseudonyms. Only de-identified research data were stored long-term (for 10 years, in accordance with university policy). The quantitative data was analysed using appropriate statistical processing (e.g., independent t-test to compare Chinese and UK groups) and the focus group data were transcribed and analysed using an inductive analysis procedure.

5.6 Results

This section focuses on the data management and analyses in Phase One. Firstly, data management was carried out. Phase One contains two initial sections: implicit association test (IAT) and questionnaire. For these processes, data management are divided into implicit and explicit data respectively. Next, the initial descriptive results of the Phase One are presented. Then, the correlations between implicit IAT D scores and the explicit WSTEM scale are strengthened. The implicit and explicit findings are explored separately. The main purpose of the implicit explorations is to identify the interactions within different groups. Finally, the explicit findings from the questionnaire data are interpreted individually using different strategies.

5.6.1 Data Cleaning

5.6.1.1 Study 1a. IAT scoring data cleaning

All data collected in IAT correspond to the participants’ reaction times in different blocks. The IAT data are transferred to IATD using the special algorithm recommended by Greenwald, Nosek, & Banaji (2003). The following section will outline this process and present the ways in which the IAT data were treated in this research.

5.6.1.1.1 IAT scoring

Before I explain how I handled the IAT data in this research, I need to first outline the traditional scoring of IAT. The IAT_{RAW} is a traditional scoring algorithm for IAT; it represents the difference between incompatible response latency (IRL) and compatible response latency (CRL). The IRL is the average latency of incompatible trails designed to be difficult for participants. The participants were expected to react more slowly when they held a gender-stereotype (or did not favour females working in the sciences). The CRL is the average latency of compatible trails, which might be faster for participants who favoured males working in the sciences and females working in the humanities. So,

$$IAT_{RAW} = IRL\text{-}CRL \quad (1)$$

where IATRAW is the IAT effect estimated using a raw response (millisecond) metric.

In addition, item-level errors (or trail errors, in this case) could be expected to be observed to some degree for stimuli presented within both compatible and incompatible blocks. “Trail error” refers to a non-systematic error, which means the participants reactions differ from other individuals, and that response speeds are shorter or longer than other trails within a given block. Trail errors might occur in different situations, particularly when there are distractions when taking the test. The IRL is the mean response collected across all of the incompatible trails, while the CRL is the mean response recorded across all of the compatible trails. Both the IRL and the CRL are computed by aggregating across all of the individuals’ trails. Trail errors are negated by a process of cancelation. As Hart, James & Christopher (2014) note, ‘Equation (1) can be viewed as a form of averaging across all items employing reverse scoring because subtracting CRL from IRL is algebraically equivalent to reverse-scoring CRL and averaging it with IRL.’ Thus, all other factors are equal. This equation is an aggregation to deal with the item-level error.

5.6.1.1.2 IAT effect interpreted by IAT_{RAW}

With a large positive score of IATRAW, an individual is considered to have a high stereotype to gender-science by IAT interpretations. IAT was originally public in the website, it offered a feedback to participants with the magnitude of implicit attitudes (biases). Cohen's (1988) criteria were used for categorizing small, medium and large effect size. To be more specific, d score for IATRAW was 0.20, 0.50, and 0.80 (Greenwald, personal communication, August 2002 from (Hart, James & Christopher, 2014)) in different effect sizes. IATRAW was used to convert to d score units by using Cohen's classic formula.

$$d = IAT_{RAW} / SD \quad (2)$$

SD was a between-subject standard deviation at a single fixed estimate of the group-level. Then respondents were labelled as having "no," "slight," "moderate," or "strong" implicit attitudes (biases) if they meet Cohen's criteria for labelling experimental effect sizes as "small," "medium" and "large."

5.6.1.1.3 IAT_D scoring algorithm

The IAT_D score (the D score, or the Opposed D score) was adapted by IAT researchers as a new IAT scoring algorithm after 2003 (Greenwald et al., 2003), as is distinct from traditional IAT scores (IATRAW). Traditional IAT scores (D score) might be confused with response speed when performing IATs (McFarland & Crouch, 2002). When taking an IAT, the faster the response speed, the smaller the D score. This tends to lower the estimated bias, reflecting a positive correlation of extremity of the IAT effects with response latency (Greenwald et al., 2003, p. 200) Greenwald et al. (2003) conducted eight algorithmic experiments with a large population to determine which was the best solution. They aimed to reduce unwanted correlations between IAT scores and average response latencies while enhancing the association with desired explicit measurements. The D score tended to have a lower correlation with response latencies compared with other algorithms.

It is defined as:

$$IAT_{D} = IAT_{RAW} / SDWI \quad (3)$$

where SDWI is a within-individual standard deviation computed by response latencies across all trails from both incompatible and compatible blocks. IAT_D ranges between -2.0 and +2.0, with large scores interpreted as having a more extreme standing on the psychological construct of interest, i.e., holding a stronger stereotype. When the score is close to zero, this is interpreted as a less extreme standing, i.e., holding more neutral attitudes. Equation (3) contributes to reducing trail error, which is desirable results for researchers.

For this research, similar effect sizes were used to classify people into categories of “no”, “slight”, “moderate”, and “strong”, with new D scores. No specific cut-values for D score have been recommended, though we used 0.15, 0.35, and 0.64 as “slight preference”, “moderate preference”, and “strong preference” respectively in an IAT measurement (Greenwald, 2002, cited in Hart et al., 2014).

5.6.1.1.4 IAT_D computation in this study

In this study, IAT_D scores were computed using R Studio (R Core Team, 2017). The script of R Studio (R Core Team, 2017) for computing IAT_D scores can be found in Appendix 8. Although in a typical IAT, there are seven blocks in total, only four blocks of data will be used in the analysis. The reason for this decision is that the first two and the fifth blocks are practice blocks, which allow the participants to understand the test. In these blocks, participants only react to a single word or image; there is no compatible or incompatible element in these blocks.

Following the recommendations of Greenwald, Nosek, & Banaji (2003), trails with latencies of more than 10,000 ms were eliminated (0.5%), and participants for whom more than 10% of trials had a latency of less than 300 ms (3.2%) were omitted. Each reaction time mean was calculated separately for Blocks 3, 4, 6 and7. Each error latency was replaced with its block mean +600 ms. Reaction times for Block 6 were subtracted from reaction times for Block 3, and the difference in the reaction time between Block 6 and Block 3 was divided by its associated pooled-trail standard deviation. The same was applied to all trails in Blocks 4 and 7. I obtained the final IAT score by averaging the two differences of the previous two steps.

Summary of IAT scoring procedures recommended by Greenwald et al. (2003)

1. Delete trails greater than 10,000 ms
2. Delete subjects for whom more than 10% of trials have latency less than 300 ms
3. Compute the "inclusive" standard deviation for all trials in Stages 3 and 6 and likewise for all trials in Stages/Block 4 and 7
4. Compute the mean response latency for each of Blocks 3, 4, 6 and 7
5. Compute the two mean differences (MeanStage6-MeanStage3) and (MeanStage7-MeanStage4)
6. Divide each difference score by its associated "inclusive" standard deviation

It should be noted that this computation is appropriate for designs in which subjects must correctly classify each item before the next stimulus appears. As participants can proceed to the next stimulus following an incorrect response, the following steps (error penalty) were taken between Step Two and Step Three:

1. Compute the mean latency of correct responses for each combined Stage/Block (3, 4, 6, 7)
2. Replace each error latency with an error penalty computed optionally as "Stage/Block mean+600 ms" or "Stage/Block mean+ twice the SD of correct responses for that stage". Proceed as above from Step 3 using these error-penalty latencies.

In this study, what was adapted by this computation is the treatment of error response. The following data was manipulated using the

3.0 software (Psychology Software Tools, Pittsburgh, PA), Excel and R Studio (R Core Team, 2017). The details of Data Management see in Appendix 8.

5.6.1.2 Study 1b. Questionnaire Data Cleaning

In this stage, explicit data refers data all collected in questionnaire. All numeric and open questions data was put into SPSS manually, they were the demographic data, the explicit favour to subjects and gender, and their associations. Several questions about participants' parents and their math scores were recorded as open questions as they were. The questionnaire contains different types of data, so the rest parts of the data in questionnaire needed to deal with different computations before analyses. Following the managements of WSTEM Stereotype Scale and The Feeling Thermometer.

5.6.1.2.1 WSTEM stereotype scale

There were 22 items in the WSTEM Stereotype Likert-type Agreement Scale used by Jackson, et al. (2014). This scale was employed in this study to test attitudes towards women in STEM. The questions regarding "Humanities" were filler items and were not included in the scale scores. After deleting the filler items, the scores of the 16 remaining questions were used to compute the final score.

In Jackson et al. (2014), the final subscale was reversed so that the resulting score reflected positive evaluations (i.e., a lack of endorsement of stereotypes). Thus, scores were reversed for Questions 1, 3, 13, 14, 18, and 19, so that all higher scores on all of the explicit scales reflected positive attitudes and lower scores on all of the sales reflected negative attitudes.

In this stage, to ensure a high degree of reliability for the questionnaire, I deleted the data for two questions in the questionnaire to reach a level of reliability equal to Cronbach's Alpha = .70. At first, the reliability test was not statistically ideal (Cronbach's Alpha =.60), although it still could indicate explicit attitudes towards women in STEM. But by checking the

"Cronbach's Alpha if item Deleted", if Q13 (.638) and Q14 (.629) were deleted from the final scoring, reliability was achieved. Thus, I deleted these two questions.

Besides their reliability, there was some confusion regarding the context of these two questions. They were reversed questions, and their related associations between gender and science were more neutral to the participants. To be more specific, Q13 was: "I like women scientists more than men scientists." This statement could lead the respondents in an opposite direction because they were women. Hence, they might well show favour to women. Q14 was: "Men publish fewer research articles than women." This statement was only vaguely related to women and science.

Furthermore, in the original plan, this scale was delicately designed with three sections and tested by Jackson et al. (2014) (the scale's pre-test was Alpha=.83 and the post-test was Alpha=.87. These did not work out in this study. Despite the filler sections, the other two sections still corresponded to each other (stereotype vs. favourability). When the two aforementioned questions were omitted, the scale was still complete in content. The unstable reliability of the scale was part of the scale and was not able to be duplicated or affected by other factors (e.g., different time, different people).

Another issue is that in the previously cited work (Jackson et al., 2014), the questionnaire was distributed to a mixed-gender sample of students. However, in the present study, the questionnaires were only answered by female students. This sample difference might be what led to internal consistency reliability, which is a measure of consistency between different items of the same construct. That means that this reliability (the value of Alpha)[9] can only be estimated in terms of average inter-item correlation or average item-to-total correlation. Nevertheless, this did not affect the data I explored. Quite the opposite, the integrity of the questions was more important in this case. Furthermore, this unstable point might be improved by focus group discussion later on to prove this.

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[9] Note that reliability implies consistency but not accuracy. A measure can be reliable but not valid if it is measuring something very consistently but is consistently measuring the wrong construct. Likewise, a measure can be valid but not reliable if it is measuring the right construct, but not doing so in a consistent manner.

5.6.1.2.2 The feeling thermometer

The other data that needed to be managed before analysing related to the Feeling Thermometer. Firstly, all of the occupations were divided into STEM (9) and Non-STEM (7) groups. A total summary of means was computed for each group using “Transform”- “Compute Variable” in SPSS. This provided the STEM_Job_Mean and Non- STEM_Job_Mean. 50 is the point that distinguishes favourability, which indicates that a rating of below 50 denotes that a respondent dislikes it and a rating of above 50 denotes that a respondent likes it (Millet, 2009).

After implicit and explicit data management were conducted, the initial descriptive results for Phase One were presented. Then, the correlation between implicit IAT D score and explicit WSTEM scale were strengthened. The implicit and explicit findings were explored separately as the interaction within different groups was the main purpose of the implicit explorations. Finally, the explicit findings from the questionnaire were interpreted one by one applying different strategies.

5.6.2 Descriptive Results

5.6.2.1 Group cell sizes

The participants’ ages ranged from 17 to 50 years old (M =23). 38.9% were undergraduate students and 36.9% were postgraduate or postgraduate research students. There were 16 students from Undergraduate Level1, 15 students from Undergraduate Level 2, 11 students from Level 3, 16 students from Level 4. Among the postgraduates, 48 were postgraduate students and 7 were postgraduate research students (i.e., PhD). After data treatment and selection, the implicit and explicit data for 113 participants from the Chinese and UK groups were stored. In the Chinese group, 20 students studied in STEM and 35 studied non-STEM subjects. In the UK group, 22 students studied in STEM and the other 36 students studied non-STEM subjects.

5.6.2.2 All variables in the scale

For convenience and to avoid confusion when using SPSS, all variables were grouped using numbers and shorter names. Nationality was denoted by the numbers "1" and "2", with "1" standing for the UK group and "2" standing for the China group. Disciplines were grouped according to whether they were STEM or non-STEM. "1" refers to STEM and "2" refers to non-STEM subjects. In some cases, participants were grouped in a different way. For instance, "1" stands for students who study STEM and were from the Chinese group, while "3" refers to the rest of the Chinese students who are in non-STEM fields. "4" represents students from the UK group who study STEM subjects. "6" denotes students from the UK in non-STEM subjects. In total, of the 113 students for whom valid data was obtained, 55 were from China and 56 were from the UK, while 42 were studying STEM subjects and 61 were in non-STEM fields.

Table 9-5.4: D Score (IAT Effect / IATD Score)

IATD scores	M	SD	SE	Total
IATD scores overall	.56	.32	.032	113
STEM-UK	.49	.33	.07	22
STEM-China	.51	.29	.07	20
STEM overall	.50	.31	.05	35
non-STEM-UK	.52	.39	.07	36
non-STEM-China	.70	.27	.05	35
non-STEM overall	.61	.34	.04	71
UK overall	.51	.36	.05	58
China overall	.63	.29	.04	55

Table 9-5.4 presented a summary of IATD scores in different groups. IATD scores may vary between -2 and +2, and not between -1 and +1, as is often erroneously stated (Greenwald & Nosek, 2006). IATD scores also refer to the IAT D effect. If they are in the (0, 2), it indicates that the participants prefer the combination in the corresponding block. The participants were faster carrying out the incompatible task when the IAT D effect was in the (-2, 0). In this study, the IAT D effect ranged from -0.25 to 1.28 (M = .57, SE = .03129). As only 10 (8.85% of all the data) negative scores were found, this suggests that there was no implicit stereotype; the participants expressed a much stronger association between males and non-STEM subjects and females with science subjects than the opposite pairings. The minimum score was -.20 and the maximum was -.03. Two of the participants (1 from STEM, -.05; the other from non-STEM, -.01) were from the Chinese group, the others were all from the UK (4 from STEM, 4 from non-STEM). Thus, there remained 103 participants (91.2%) that had a positive D score. This indicates that the majority of the people in this study had a gender-science stereotype; however, I did not know whether there were differences within countries and subjects.

Figure 8-5.2: D Score for Groups

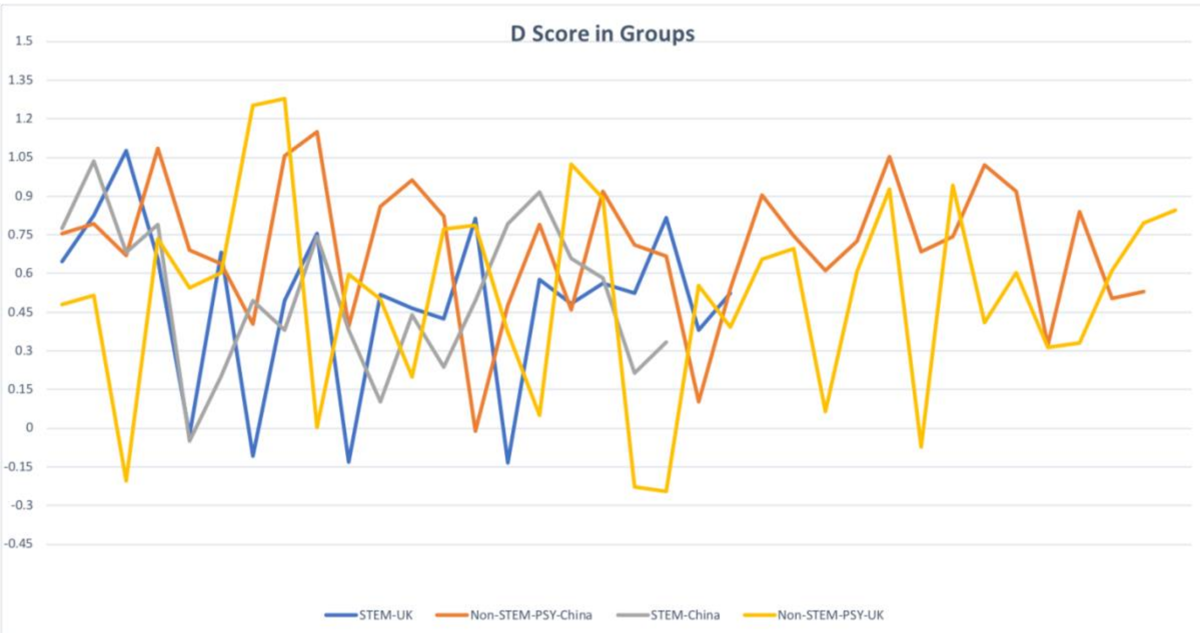


Figure 8-5.2 shows the D score patterns for the different groups. Both the highest score (1.28) and the lowest score (-.25) were in the non-STEM UK group. Both the STEM and non-STEM Chinese groups had positive scores.

5.6.2.3 IAT Effect Size

No publication has stated that the IAT Effect has an official effect size point. Normally, the effect breaks points labelled “slight” (.15), “moderate” (.35) and “strong” (.65) are selected conservatively according to psychological conventions for effect size. Scientific reports of the IAT D effect are available in Greenwald, Nosek, & Banaji (2003) and Nosek, Greenwald & Banaji (2006). An example of results for the IAT rate is available in Nosek, Banaji, & Greenwald (2002). IAT effect the meaning of in general, however, they will explore with ANOVA in the following analysis.

Figure 9-5.3: D Score Effect Size in Groups

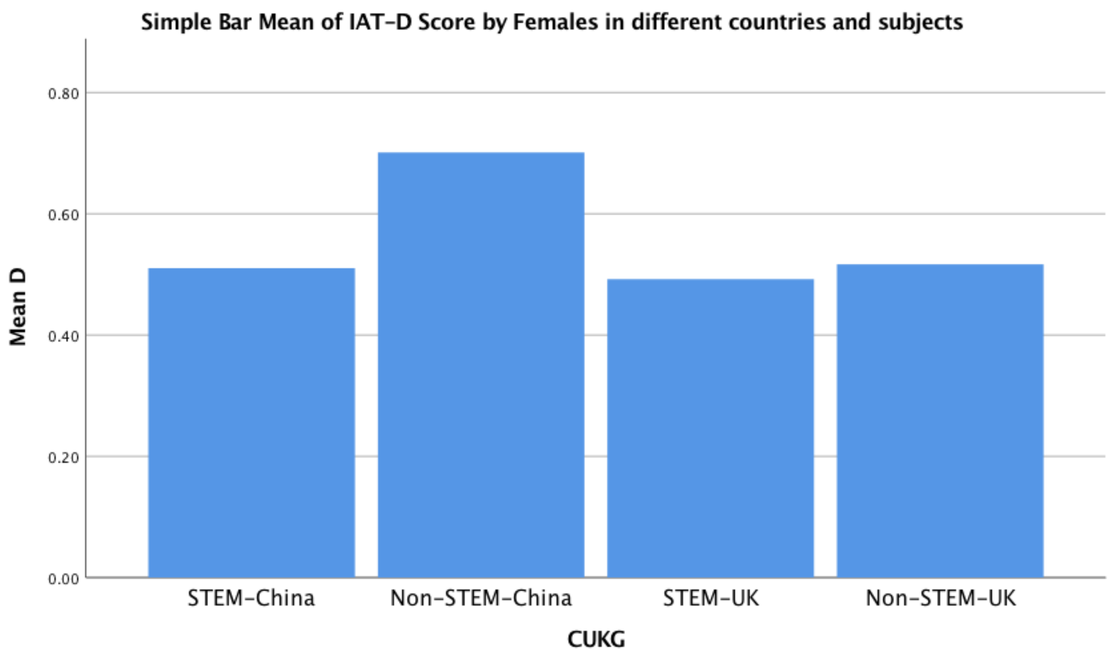


Figure 9-5.3 shows the distribution within diverse IAT effect sizes across different groups.

Based on different break points, if the score falls in the 0.15 - 0.35 range, this indicates the subjects had a slight implicit gender-science stereotype; i.e., they tended to associate males with STEM and females with non-STEM subjects. Only a small number of people fell into this range in the STEM-China group (4), non-STEM-UK group (3) and the non-STEM-China group (1).

Furthermore, if the score was between .35 and .65, the subjects had a moderate implicit stereotype. In each group (39 in total), this was the largest population. Looking in detail I see that half of the participants in the STEM-UK group were in this range, which was 19% of the total UK group, and 26.2% of the two STEM groups, compared to 10.9% of the Chinese groups and 14.3% of both STEM groups. The other two non-STEM groups also showed a large population in this range.

Finally, any score above .65 indicates the participants hold a strong implicit stereotype. This was the second largest population (37 in total) in all of the other ranges. Looking at the groups in detail, 22 non-STEM Chinese participants had a strong implicit stereotype, which accounted for 40% of all Chinese participants and 31% of all non-STEM participants. To sum up, the majority (76) of scores were above .35, which indicated that 67.3% of the participants had a moderate or strong implicit gender-science stereotype. In general, the Chinese women tended to have higher IAT scores than the UK females, especially the non-STEM Chinese students, which means that the Chinese women might have a stronger implicit stereotype than their UK counterparts. There was no clear indicator of differences between subjects or countries.

Figure 10-5.4: Explicit Variables

Explicit Variables	M	SD	SE
STEM associated with gender	3.33	1.26	.12

non-STEM associated with gender	5.09	.96	.09
attitude to non-STEM	4.00	.97	.09
attitude to STEM	3.65	1.22	.12
STEM_Job_Mean	71.65	90.28	8.49
Non-STEM_Job_Mean	76.93	89.20	8.37

Table10-5.4 showed all explicit variables. I explored the normality of the variables before running statistical analysis. The distribution was indicated by the skewness of -.51 and the kurtosis of .007. WSTEM (M= .2.68, SD= .32), the median was 2.68. The distribution of WSTEM was verified by the skewness of -.17 and the kurtosis of -.21. The histogram verifies the symmetry.

5.6.2.4 Both parents work or were educated in STEM

I also considered the participants' parents' education and occupations, as they might be factors that affect their attitudes towards STEM. There were 66 parents who had neither a STEM-related education nor worked in STEM, and 29 parents who had both a STEM-related education and worked in STEM. Only 13 parents had a STEM-related education but did not work in STEM. And there were 5 parents who worked in STEM but had no STEM educational background. I used Chi Square statistics to explore the parents' educations and occupations to identify to what extent these affected the female's stereotypes.

5.6.2.4.1 Chi square (parental education and occupation)

Parental education (in STEM or not) * Nationality (UK or China). There was strong evidence of a relationship between parents' education (in STEM or not) and nationality, $X^2(1, N = 113) =.030$, $p < .05$. This might indicate that the Chinese participants' parents were more educated than those of their UK counterparts.

Parental education (in STEM or not) * Subject (STEM or not)

There was no evidence of a relationship between parents' education (in STEM or not) and nationality (Chi-square=.004 ， df = 1, p =.95). Parental occupation (in STEM or not) * Nationality (UK or China). There was no evidence of a relationship between parents' occupation (in STEM or not) and nationality (Chi-square= .738， df = 1, p =.390).

Parental occupation (in STEM or not) * Subject (STEM or not)

There was no evidence of a relationship between parents' occupation (in STEM or not) and nationality (Chi-square= .112， df = 1, p =.738).

Parental Education (within Chinese group)

There was no evidence of a relationship between parents' education (in STEM or not) and nationality (Chi-square= .094 ， df = 1, p =.759).

Parental Education (within UK group)

There was no evidence of a relationship between parents' education (in STEM or not) and nationality (Chi-square=.02 ， df = 1, p = .887).

Parental occupation (within Chinese group)

There was no evidence of a relationship between parents' occupation (in STEM or not) and Chinese female students choosing STEM or non-STEM (Chi-square= .414, df =1, p =.52).

Parental occupation (within UK group)

There was no evidence of a relationship between parents' education (in STEM or not) and UK female students choosing STEM or non-STEM (Chi-square=.02 ， df = 1, p =.887

5.6.3 Relationship between Measures

5.6.3.1 Correlation between implicit and explicit measures (D and WSTEM)

A correlation was run between implicit and explicit stereotypes, as is typical in IAT research, in order to examine the extent to which implicit stereotypes relate to explicit stereotyped attitudes in this sample. The IAT D Score (Kolmogorov-Smirnov[a], p=.061, Shapiro-Wilk, p=.011) and the Questionnaire Mean Score (Kolmogorov-Smirnov[a], p=.024, Shapiro-Wilk, p=.322) did not exhibit normal distribution, Spearman correlation used for assessing the relationship between IATD score and WSTEM score. There was a positive correlation between variables (Spearman Correlation), r=.219, n=113 p=.020. This means when IAT score increases, the WSTEM score will get higher. albeit, this significant relationship is weak, as is typical for IAT research.

5.6.3.2 Correlation between age and implicit measure

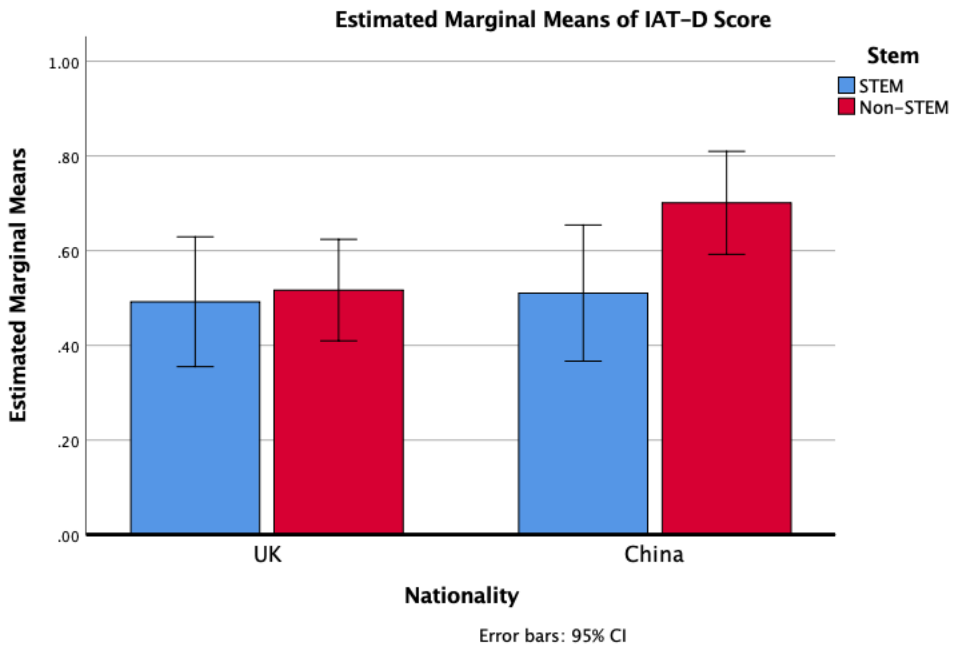
A Pearson correlation coefficient was computed to assess the linear relationship between age and IATD score. There was no correlation between variables (Pearson Correlation), r=.-.046, n=113 p=.63. This means when age changes, the IATD score has no changes.

5.6.4 Study 1a. Implicit Results

An ANOVA of Between-Subjects effects was run on the IAT_D score, nationality and STEM subjects (psychology as a non-STEM subjects). As Figure 7-8.3 shows, there was no statistically significant interaction between STEM and Nationality and IAT Effect [F (1,109) = 1.724), p= .192]. Also, there was no main effect for STEM study, F (1,109) = 2.897), p= .092, indicating that female students studying in STEM had similar scores (M = .50) as female students studying non-STEM subjects (M = .61). No significant main effect was obtained for nationality level, F (1,109) = 1.724), p= .192. The female students had very similar IAT-D score from the UK group (M = .50) and the China group (M = .61).

Historically in the social sciences, the STEM main effect finding at p<.10 might have been discussed as a possible 'trend' toward a difference, with STEM students showing a weaker implicit stereotype, however, given current issues of replicability in implicit measures, we are treating this finding as non-significant. However, the power issues of the sample size will now be addressed, with acknowledgement that these results may show a Type II error of lacking power to detect a possible main effect.

*Figure 11-5.4: 2*2 Anova (D between nationality and subject*



Although *Figure 11-5.4* there is no statistical difference. Regarding the effect size, this might be explained by the fact that a main interaction is considered hard to achieve (Leon & Heo, 2009). Indeed, the sample size required to detect a 2*2 factorial design interaction in a mixed-effects linear regression model is four times that required to detect a main effect of the same magnitude by a simulation study.

According to Cohen's (1988) guidelines, assuming effect size for η^2 multiple regression, Small:0.02, Medium: 0.13, Large: 0.26.

Effect size: $\eta^2 = \frac{\text{Treatment Sum of Squares}}{\text{Total Sum of Squares}}$

η^2(Nationality)= .005 (small) indicates that 0.5% of the implicit scores' fluctuation is due to nationality; η^2(STEM)=.006(small) indicates that 0.6% of the implicit scores' fluctuation is due to the STEM; η^2(Nationality*STEM) =.003 (small) indicates that 0.3% of the implicit scores' fluctuation is due to the interaction between nationality and STEM.

G Power: within-subjects, confidence level of .05 and power of .08
sample size 128. between-subjects 4* 128

5.6.4.1 *Planned Comparison for Chinese group*

As mentioned before, the ANOVA interaction between subject of study and nationality was not shown statistically, although this may be due to inadequate sample size. In classical statistical approaches the lack of an overall interaction usually precludes further tests for simple effects. However, this thesis has justified throughout the specific planned directional contrast at the heart of this thesis is the comparison between Chinese women studying STEM versus those who are non-STEM students. It was further hypothesised that the UK sample would have reduced, or perhaps no stereotype expression (on implicit and explicit measures). In such an instance, the overall interaction may indeed be non-significant, but mask the intra-group difference for Chinese women only. Therefore, in line with prior theoretical and statistical justifications, I ran a t-test for simple effects, to explore implicit and explicit gender-STEM stereotype differences for Chinese women below; the same condition applied to explicit finding below.

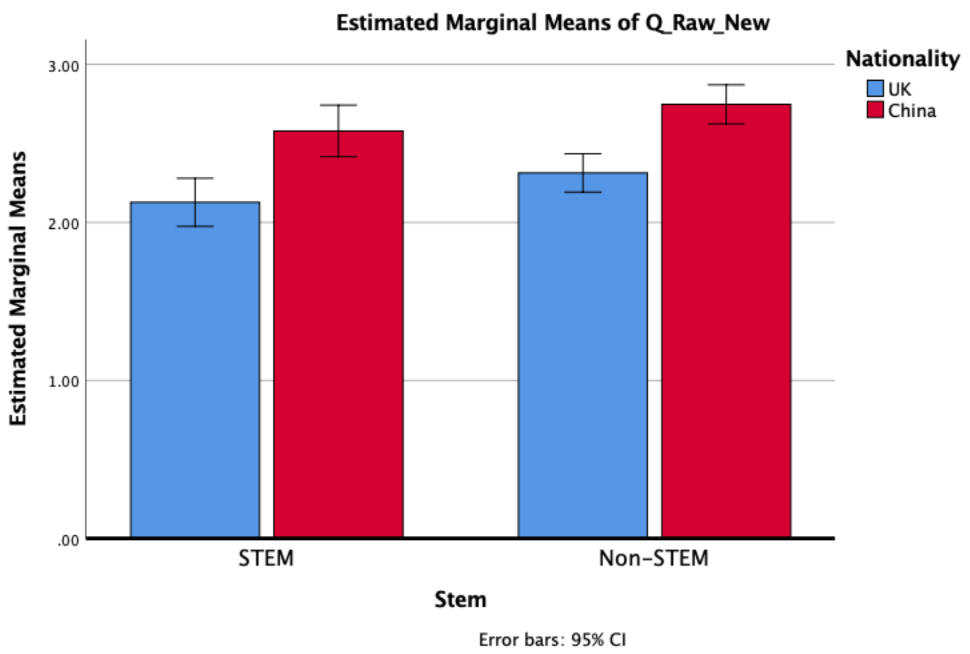
5.6.4.2 *D for Chinese group*

The results of the independent t-Test were significant, $t(53) = 2.50$, $p=.016$, indicating that there was a significant difference in IAT-D scores between the Chinese Women in STEM ($M=.51$, $SD = .29$, $n= 20$) and the Chinese Women in non-STEM subjects ($M = .70$, $SD =.27$, $n = 35$). There was a 95% confidence interval for the difference between the lower and upper bounds of the two means. Cohen's d t-Tests Small:0.2, Medium: 0.5, Large: 0.8.

According to Cohen's (1988) guidelines, Effect size: Cohen's d = $(M_2 - M_1)/SD_{pooled}$, where $SD_{pooled} = \sqrt{((SD_1^2 + SD_2^2)/2)}$. Cohen's d = .69 (medium) indicates that 69% of the change in the IAT scores could be accounted for by Chinese students' subjects (STEM or not).

5.6.5 Study 1b. Explicit Results

*Figure 12-5.5: 2*2 Anova (Questionnaire mean between Nationality and Subjects)*



*5.6.5.1 2*2 ANOVA between nationality and subject of study on WSTEM score*

A two-way ANOVA was performed to analyse the effect of national difference and subject difference on WSTEM score, which measures the association the participants had of women with science, computed into an average explicit gender-STEM stereotyped attitudes score. As Figure 8-8.4 shows, there were significant main effects found for both nationality, $F(1, 109) = 40.546$, $p < .001$ and subject of study, $F(1, 109) = 7.024$, $p = .009$. Given the complexity of the 2*2 ANOVA designs, and the necessity to keep implicit findings separate, a Bonferroni correction was applied here given the total 5 ANOVA comparisons, $\alpha_{adjusted} = \alpha/n = 0.05/5 = 0.01$.

Thus, I should only reject the null hypothesis of each individual test if the p-value of the test is less than .010. As both p-value were less than .010, there remains a statistically significant difference when the correction is applied. This indicates that women from China show greater explicit gender-STEM stereotypes than women in the UK. Also, women who study non-STEM subjects show greater explicit gender-STEM stereotypes than women in STEM fields. There was no significant two-way interaction between nationality and subjects, F (1, 109) = .084, p = .773.

5.6.5.2 Planned independent contrast- WSTEM scales by Chinese group

A planned independent t-test was performed to carry out the planned contrast on explicit WSTEM score between Chinese women who study STEM and those who did not, the results of this test, unlike the implicit comparison, were not significant, t (53) = -1.432, p= .16; indicating that there was no significant difference in WSTEM score between the Chinese women in STEM and the Chinese women in non-STEM subjects. There was a 95% confidence interval between the lower and upper bounds of the two means.

*5.6.5.3 2*2 ANOVA between nationality and subject of study on the single item measure of 'liking' STEM subjects*

An ANOVA was then conducted for these female students' personal preference towards STEM subjects, that is their liking toward STEM subject on a single item measure. There was initially a significant main effect both of nationality, F (1, 109) = 4.68, p = .03 and subject of study, F (1, 109) = 30.54, p < .001. Since the p-value for subject of study was less than $\alpha_{adjusted}$ =0.01, there is a statistically significant difference on subject of study post-correction, however the national differences are no longer significant. This means that women who study STEM subjects had more positive attitude towards STEM than women in non-STEM fields, as might be expected. However, I lose the finding that women from China show less positive attitude to STEM subjects in general than women in the UK. No significant two-way interaction was found, F (1, 09) = 3.19, p = .077, however again, this might historically have been viewed as a 'trend' toward significant in social science, and given the caveats of statistical power above, it is worth highlighting liking of STEM as worthy of further research in future, specifical exploring Chinese women's warmth toward STEM study.

5.6.5.4 2*2 ANOVA - *explicit preference on the single item measure of 'liking' Arts and Humanities subjects*

An ANOVA was then conducted for these female students' personal preference towards STEM subjects, that is their liking toward Arts and Humanities subjects on a single item measure. As above, there were significant main effects found both of nationality, F (1, 109) = 4.06, p = .046 and subjects, F (1, 109) = 4.24, p = .042. *As the p-values were both larger than* $\alpha_{adjusted}$ = 0.01, I rejected these results, to avoid type I error. This means that each group produced the same mean of liking score. This means post-corrections I lose both findings that women who study non-STEM subjects had more positive attitudes to Arts & Humanities than women in STEM fields (as might be expected). Furthermore, I lose findings that women from China might show more positive feelings towards Arts and Humanities subjects than women in the UK. There was no significant two-way interaction found between nationality and subjects, F (1, 109) = .01, p = .94.

5.6.5.5 *2*2 ANOVA between nationality and subject of study on feeling thermometers female STEM occupation between nationality and subjects*

There was no significant two-way interaction found between nationality and subjects, F (1, 110) = .763, p = .384. There were no significant main effects either of nationality, F (1, 110) = 1.74, p = .191 or subjects, F (1, 110) = .166, p = .69.

5.6.5.5.1 Female non-STEM occupation between nationality and subjects

There was no significant two-way interaction between nationality and subjects, $F(1, 110) = .672$, $p = .414$. There were no significant main effects either of nationality, $F(1, 110) = .562$, $p = .455$ or of subjects, $F(1, 110) = .530$, $p = .468$.

5.7 Summary and Discussion of Significant Findings in Phase one

The quantitative analyses in this chapter revealed that the women in this cohort did on average hold implicit and explicit gendered attitudes towards women working in STEM fields compared to prior generalisable study findings using these standardised measures. There was a weak positive correlation between these two types of stereotypes- explicit and implicit gender-STEM attitudes- which suggests that one’s implicit gendered attitudes are to some extent linked with one’s explicit attitudes, although they may indeed tap different cognitive and affective aspects of gendered stereotypes; with the former more likely developmentally and culturally ingrained at a sub-conscious level, and the latter more consciously constructed through experience. The extent of the gender-STEM stereotypes was further shown to vary between the different cohort sub-groups.

Analysis of explicit gender-STEM attitudes on the WSTEM revealed international differences, such that the Chinese women in the sample tended to report higher levels of explicit gender-STEM stereotypes than women in the UK. At the same time, there were consistent differences depending upon subject of study on explicit attitudes, which revealed that regardless of nationality, women studying STEM subjects reported less explicit gender-STEM stereotypes than women in non-STEM fields. These findings persist despite Bonferroni’s corrections, but I lost many of the findings around warmth and liking for STEM subjects and arts/ humanities, and there were no thermometer findings. The remaining significant finding was that women who study STEM subjects had more positive attitudes (liking) towards STEM than women in non-STEM fields, as might be expected. There were no interactions between nationality and subject of study, nor was there a significant planned contrast for intra-national group differences in the Chinese women.

When considering the finding of the implicit measure of stereotypes, using the IAT to detect implicit gender-STEM stereotypes, revealed no main effects, neither for nationality, nor subject of study differences. There were also no significant interactions found. Although the chapter addresses the finding which would historically have been classified as a trend toward significance (at $p<.10$), and the possibility of these subtle effects being under-powered by the low sample size were also highlighted. However, the planned intra-group comparison for the Chinese women (using an unrelated t-test), revealed differences within the Chinese sample, indicating that Chinese women studying STEM subjects had weaker implicit gender-STEM stereotypes than those Chinese women not studying in STEM fields ($p<.05$). This is interesting given these subtle stereotypes may play a role consciously or not in subject matter choices, and/or reinforce the drive to identify with and remain in one's chosen field of study. In this instance, particularly for Chinese women studying STEM (or choosing not to study STEM), not only explicit attitudes, of which I may be aware, but also implicit stereotypes, of which I may have unconsciously developed via cultural and familial exposure, may both play a role in subject choice.

The quantitative analyses in this chapter revealed that the women in this cohort did on average hold implicit and explicit gendered attitudes towards women working in STEM fields compared to prior generalisable study findings using these standardised measures. There was a weak positive correlation between these two types of stereotypes- explicit and implicit gender-STEM attitudes- which suggests that one's implicit gendered attitudes are to some extent linked with one's explicit attitudes, although they may indeed tap different cognitive and affective aspects of gendered stereotypes; with the former more likely developmentally and culturally ingrained at a sub-conscious level, and the latter more consciously constructed through experience. The extent of the gender-STEM stereotypes was further shown to vary between the different cohort sub-groups.

Although this research contained an adequate number of participants, it did not contain a large number in one sub-group (cell for Chinese women in STEM) there was also not an equal number in each group. Due to limited time and the feasibility of data collection, it was not possible to obtain equal numbers for each group based on the power analysis in phase one. However, the sample size was sufficiently large to meet the standard for statistical analysis. The reasons why there was not an equal number of women in each group are complicated. Firstly, it is not easy to recruit women in STEM fields, particularly in some core hard science subjects (e.g., physics), where women are less represented. However, although STEM subjects are not popular among Chinese women who study abroad, those that do study these subjects mainly remain in higher education. This represents a strong point, as I was able to find Chinese women with a higher level of education (despite their underrepresentation). To overcome such difficulties in future, I would enlarge the number of participants in each group, if possible, to see if the main effect differences are found between the nationalities.

5.7.1 Discussion and Correspond to Hypotheses

The aim of the present research was to test Hypothesis 1 (H1), which posited that Chinese students in all fields, regardless of subject of study, would hold greater implicit and explicit gender- STEM stereotypes than female students from the UK. In terms of the explicit measures, the results partially support H1, as the empirical data showed differences between the UK and China subjects regarding explicit (but not implicit) gendered attitudes to women in STEM, with Chinese women tending to have higher explicit gender-STEM stereotypes than women from the UK (e.g., Li & Kirkup, 2007). There is not a great deal of research comparing women studying in STEM or non-STEM fields from these two countries. Nevertheless, the underlying reasons for these differences found between the two groups might be the different cultural impacts on women from these countries, especially the Chinese women. A discussion of cultural impacts on Chinese women will be provided in the final chapter.

Hypothesis 2 (H2) posited that women in STEM fields, compared with women in non-STEM fields, would show weaker implicit and explicit gender-STEM stereotypes. H2 was also partially supported, with the women from both countries studying in STEM showing less explicit gender-STEM stereotypes than women not studying in STEM fields. However, no such findings emerged from the implicit measures. These findings are consistent with females holding weaker implicit gender-STEM stereotypes than females in humanities. For instance, Smeding (2012) found that female engineering students from southern France held weaker implicit gender-math stereotypes than women in non-STEM fields. This might offer an explanation for why women studying STEM fields chose STEM subjects, as they might perceive less explicit gender-STEM stereotypes that make it easier for them to make the choice; this also fits in with the argument that job segregation leads to female scientists suffering gendered discrimination (e.g., during the hiring process), which impedes women's participation at higher levels of STEM fields (Ecklund, Lincoln, & Tansey, 2012).

The next hypothesis tested was H3, which posited the interaction between nationality and subject of study and explicit and implicit attitudes. The assumption was that Chinese women studying non-STEM subjects would exhibit stronger implicit and explicit gender-STEM stereotypes than British women. This hypothesis was not supported statistically - despite the above noted trend toward significant for the interaction (at $p<.10$, also likely due to the lack of power provided by the small sample size).

However, the planned comparison (H4) narrowing down to specifically explore intra-group differences amongst the Chinese sample only. The findings here indicated significant differences regarding implicit attitudes between women from STEM and non-STEM fields. A recent report by Forgasz, Leder and Tan (2014) presenting empirical data about women in STEM fields from the UK and China also showed the trend that Chinese women might hold higher gender-STEM stereotypes than British women. For instance, Chinese women (48.2%) were found not to be as confident as women in the UK (78.4%) regarding their mathematical ability, which could also be linked to traditional Chinese culture and explain why the Chinese sample only revels such differences in the implicit measurement. When considering the quantitative results holistically, many more reasons need to be considered: 1) it does appear there are international, and subject of study differences as regards stereotype content, and more specifically the Chinese women cohort reveal implicit differences in their stereotype strength according to subject of study. These findings should compare China's differing trends of feminist movements compared with the UK (Jolly & Huibo, 2018), which was a more top-down approach of policy statements to gain female rights and equality, as opposed to a more grassroots social movement (see also Karl, 2012). This might have led to some un-complete issues as regards individual-level psychological movements toward emancipation, as well as with long-lasting traditional cultural impacts in overt conflict with these new policy shifts (e.g., only a "slogan", Thornham & Pengpeng, 2010), In other words, there may have been, and continues to be a lack of individual initiatives for women to acknowledge and fight for equality openly and led by and for women. 2) Other Chinese special policy might cross this as well, such as the one-child policy, which made a girl more 'special' in a one-child family context, and "upgraded" girls to be educated and aspirational (whereas this used to be "boys" only), especially in middle-class family context (note: international students in UK HE tend to be from good educated and wealthy family in China; Tu, 2018; Xie, 2021). 3) Social trends happen in this group, such as labelled as "left-over women", which still lay out women discrimination in structure (Hong Fincher, 2014). 4) Women identity as collective rational construction, expect biological given features, for Chinese women, the stereotypes from culture differences on gender which are internalisation of the patriarchal family and social relations (Leung, 2003). The most strike phenomena for Chinese HE women are WLB (Ren & Caudle, 2020). 5) on the top of all these reasons, as international students, Chinese women experience interculture differences when they pursue STEM careers in the UK, which makes new layer to this issue (Bamber, 2014).

The last hypothesis (H5) from Phase One was that there would be a correlation between explicit and implicit gender-STEM stereotypes. This correlation was found as expected. There might be several reasons for the relatively low explicit gender-STEM stereotypes. If there is a high explicit stereotype, then it is likely there is a higher implicit stereotype. This indicates that implicit measures may indeed be in line with but more subtle than explicit measures of stereotyped and prejudiced attitudes. Another reason why participants might report these stereotypes in the explicit measures is that as they are in STEM fields, they might feel less self-confident. From the measures, it was found that the participants tended to be more alert in psychological studies (lab), expressing more self-doubt and self-protection, because they could take as much time as they wanted when completing the questionnaire. Also, women are more likely to prefer explicit measures than implicit measures related with gender-STEM stereotypes (Nosek et al., 2002; Greenwald & Banaji, 2017). Pronin, Steele, and Ross (2004) published relevant findings regarding how successful women under gender-STEM stereotype threat explicitly denied some feminine traits (e.g., a nurturing instinct, sensitivity, and empathy).

However, Stout and his colleges (2011) argued that those feminine traits in Pronin et al.'s studies might be limited in their application to certain female groups and that students in STEM fields would have a stable explicit attitude towards STEM fields. Even though the implicit (IAT) and explicit (WSTEM) results are correlated, they are rather weak. As I expected in Hypothesis 1, female students in STEM fields have implicit and explicit gender-STEM stereotypes. In addition, these participants tended to show weak or moderate implicit gender-STEM stereotypes, which is consistent with many previous studies (Smeding, 2012). This could be explained by the assumptions of a relationship between implicit and explicit measurements. From the MODE model's dual-process interpretation, implicit and explicit measurements should be correlated as they are similar within the same cognitive processing system but with two different attitude constructs (Fazio & Olson, 2003). Thus, the weaker relationship between implicit and explicit measures might be because the subjects are highly motivated and able to control themselves on explicit measurements, especially regarding socially sensitive topics (Hofmann, Gawronski, Gschwendner, Le, & Schmitt, 2005). Although the topics relating to gender stereotypes were sensitive for the participants, they might be able to control their explicit attitudes as they were not subjected to time limits during the explicit measurements.

6. CHAPTER SIX: PHASE TWO QUALITATIVE STUDY 2- FOCUS GROUPS ACROSS TWO NATIONS

Based on the quantitative phase one results and the literature review, this second phase consisted of conducting qualitative research. This chapter describes the qualitative phase two of Study 2, focus groups between two nations. Data were gathered from two focus groups with British and female STEM students in the first half of the qualitative methodology, In the analysis of the data, the present chapter presents an inductive thematic analysis (TA) for focus group findings, Thus, this chapter presents the methodology, procedure and findings for the focus groups with British and Chinese students (Study 2). It will go further into study details, the overall trustworthiness, qualitative data analysis, the positionality of the researcher and other considerations will discuss first as these across the qualitative phase of research.

A qualitative approach was deemed most appropriate to achieve the **Overarching aim 2** of exploring additional factors that positively influence women's decisions to study STEM leading up to their postgraduate studies in the UK, as well as identifying the key facilitators, barriers, and transition points that retained both UK and Chinese women's progression in STEM at the postgraduate level and beyond. In other words, a qualitative Phase 2 was conducted to unpack the characteristics of successful British and Chinese female HE STEM students, including any cultural differences between UK and Chinese cohorts. Accordingly, an inductive approach was adopted to understand the nature of the data within this sample without imposing any interpretation from pre-existing findings or theory (

, 2002).

Given the cross-cultural element of this thesis, it should be noted that Chinese was used to communicate with Chinese participants during focus groups and interviews. To keep the data as close to the original as possible, I analysed the transcripts in Chinese first, and only translated key terms and sentences to facilitate reporting of the findings[10]. This approach is efficient for conducting translations and helps the researcher to extract more sense out of the transcript data (e.g.,

[10] This issue is often given little or no attention in cross-cultural research. After communicating with many Chinese-English researchers and supervisors, this strategy seemed promising and widely accepted.

& Kobayashi, 2019). To minimise the risk of data becoming lost or misunderstood, the translations were subsequently checked by three Chinese-English speaking colleagues[11].

6.1 Considerations for Qualitative Phase

6.1.1 Qualitative Data Analysis

Qualitative data analysis, as Miles, Huberman and Saldana (2014) state, is a ‘contiguous, iterative enterprise’. Given that both quantitative and qualitative data are collected, there are two potential ways to approach the qualitative data. One of the ways begins with checking how the qualitative data enables further explanations of the quantitative findings, while the other method starts with an exploration of the qualitative data itself, without reference to any quantitative findings. These two options were identified by Miles and his colleagues (2014, p. 185). As primary methods of qualitative analysis, either starting with ‘conceptually specified categories... (deductively)’ or reaching them ‘gradually (inductively)’. The inductive approach was adopted at the early stage of the qualitative analysis. This way of analytical work is expected to explore and understand the nature of data in this sample without imposing any interpretation from pre-existing findings or theory, and it was more data-driven (Gibbs, 2002). In other words, the qualitative data was initially approached with a focus only on the data itself, rather than based on the literature, pre-findings or other preconceptions.

6.1.2 Translation issues in Qualitative Phase

It should be noted that, as the participants were made up of two different nationalities of students, to help them understand and interpret the questions as much as possible, Chinese, their first language, was used to communicate with other participants or the interviewer during

[11] Since all transcripts were anonymised, there was no explicit permissions needed for translation checking.

focus groups and interviews. To keep the data as close to the original as possible, for the transcript analysis, I analysed them in Chinese first, and only translated key terms and sentences to help to understand the results and generate findings. All of these steps were conducted first by the researcher and then checked by three Chinese-English speaking colleagues regarding the translation. This minimised the risk of data becoming lost or misunderstood. This issue is often given little or no attention in cross-cultural research. However, after communicating with many Chinese-English researchers and supervisors in the same situation, this strategy seems promising and widely accepted. This approach is also efficient for conducting translations and helps the researcher to extract more sense out of the transcript data (e.g., Elliot & Kobayashi, 2019). I asked colleagues help me check transcripts. After I analysed all the data, themes and key words from the transcripts were checked to make sure my translations were clear.

6.2 Methods

6.2.1 Research Design and Focus Groups Protocol

The results of phase one revealed that both nationalities of women studying in STEM have gender-science stereotypes to different extents. The reasons could be various as there are many factors and cultural differences. I have a vague idea of what might be the reasons based on the literature and experiences of life, e.g., life experiences (characteristics), parents' (or guardians') influence, role models and cultural impacts (see literature review in Chapter 4). To understand this better and more scientifically, the focus group questions were designed to explore educational trajectory issues with both nations. The qualitative work forms the second stage of the research and was informed by the results of Phase 1 (see section 5.6), which suggested that the interesting results of the Chinese group need to be explored to develop a deeper understanding. The first half of the qualitative work consisted of one focus group for each nationality, comprised of female participants studying in STEM fields here in the UK. Interviews were conducted to develop a deeper understanding of the experience of being a Chinese woman studying in STEM fields. The focus groups aimed to explore the factors that might have an impact on the gender-science stereotypes of being women in STEM fields across two countries.

6.2.1.1 Approach to Focus Group

Focus groups are a commonly used strategy in quantitative research. They are efficient and boost the collection of quantitative data (Wilkinson, 2011). Also, for the comparison purposes of this study, I tried to identify some common ideas of the situation of women studying in STEM. Thus, some common phenomena or problems emerged from the discussions. Furthermore, when new issues arose, the subjects were encouraged to talk by the feedback they received and the reflections they heard from the others. Focus groups are suitable instruments for exploring the research questions.

Furthermore, part of the design and questions were driven by the results of the first phase. After analysing the quantitative results, a main question remained as to why Chinese female students hold greater gender-science stereotypes of women in STEM, regardless of whether or not they were studying in a STEM field. This question became far more interesting when it came to the Chinese group, who should be likely to hold stronger gender stereotype of STEM subjects, while the UK-STEM group seemed to be rather weaker in regard to the strength of this learned association. Therefore, the Phd research students represent a situation of being successful learners and very likely pursuing a career in STEM fields, which illustrated that they were the ideal female groups to unpack my overarching research question 2. Also, I will explore deeper on how Chinese women have achieved a successful earlier career in STEM fields in the next study 3 in the next chapter.

Focus groups are one way to collect data from multiple participates at the same time. "They involved a relatively unstructured, but guided, discussion focused on a topic of interest" (Braun and Clarke, 2013, p.108). The focus group can access some knowledge that other form of methods would not (Wellings, Branigan & Mitchell, 2000), especially on generating novel and unexpected issues (Wilkinson, 1998). The 'naturalistic' aspect is the most beneficial for focus groups as opposed to individual interviews, it's more like regular conversation (Wellings, et al., 2000). It encourages participants to talk to each other, rather than to the researchers, in a more natural and 'real-life' setting. Thus, they could talk in more depth about sensitive issues with an open supportive environment- when handled sensitively (Wilkinson, 1998a). Also, the most distinguishing feature of focus groups is the social interactions among group members, which offers potential social situations (Hollander, 2004), as the 'real-life' situations, interactions between participants could elaborated and details accounts (Wilkinson, 1998; Wilkinson, 1998a). The process of focus groups could be seen as 'decontextualization of data collection' using social interaction (Wilkinson, 1999). This means that all process of focus group could be treated as an element to data collection. The data of focus groups can further access how people negotiated, elaborated, and justified on the same topic, which are the different aspects of people sense-making (Frith, 2000; Wilkinson, 1999). For instance, in my focus group process below, the response to a question of interests about STEM subjects might generate only several answers for participants, but in a social setting, participants were free to gather others' thoughts and comments.

Furthermore, focus groups are suitable methods for collecting wide range of perspectives, views and understanding of issues (Underhill & Olmsted, 2003; Wilkinson, 1998a.) Focus groups are good for exploring issues rather than validating empirical findings Frith, 2000). With all respects of positive and supportive ethical environments put into place for sharing with people in their groups, focus groups are suitable for marginalised and underrepresented social groups to access their views and understandings (Wilkinson, 1999). The main benefit within focus groups might be that participants do not speak to researchers directly, only sharing views with people like themselves, which is less intimidating (Liamputtong, 2006). For instance, in my focus groups I had directly asked about parents of a single individual, they might not have felt as able to discuss much in the focus groups, whereas in the focus group when I asked what they found obstacles in these fields, the group were able to facilitate and open conversation around their feelings and shared their commons.

From the process of focus groups in terms of discussion contexts, focus groups could really enhance topics by raising 'conscious-arising' effect after others sharing their perspectives on the topics (Wilkinson, 1999). Thus, different individual consciousnesses arise in group contexts, which foster powerful and intensive social interactions for the topics. For those groups of people feeling venerable to some extent in public, those focus groups could empower them when they find they are not 'alone' and isolated in their experiences and perspectives (Liamputtong, 2006; Wilkinson, 1999). For instance, an issue which participants might previously have felt alone in was the experience of being judged to find STEM subjects as interests, however, once the group discussed it, there was a collective consciousness raising that this was a shared experience.

However, this method is also facing many criticisms due to its group-based nature. On the one hand, the criticism of focus groups is researchers may misuse or waste these contextual and interactive data (Hollander, 2004; Kitzinger, 1994), or group bias may lead to improper data production (Farnsworth & Boon, 2010), or perhaps there will be a lack of depth in group-level analysis (Webb & Kevern, 2001; Wilkinson, 1999). To acknowledge this criticism, as the moderator I facilitated participants' discussion around the topics, and as the note keeper, would trace when there were no main questions left. Also, I was more devoted to reflexivity both within the data collection and on the data analysis, bringing in my own experiences, and making explicit how my experiences may affect the group-based interaction and analysis. Furthermore, the purposes of focus group in this phase were getting as much empirical data as possible from women in STEM fields to give underlying developmental experiences about Gender-STEM stereotypes, and more deeply reflecting on other remaining reasons for women's underrepresentation in STEM fields.

Other considerations for focus group design were how to divide participants into different groups. I chose to group by nationality, instead of mixed nationalities. One of the purposes for the focus group was to explore the differences and similarities along their STEM educational trajectories from two different national backgrounds, as one cohort from a single country, and similar culture background could inspire each other's discourses, and achieve richer data. Otherwise, mixed national groups could easily be distracted by the other country because of background differences needing to be explored in situ. if I am seeking some advice for educational journeys and future career purposes, it is better for cross-cultural differences to emerge at the analysis stage. Another concern was for the language differences. Although the

Chinese group could frequently speak and express themselves in English, for some specific cultural content it may be still hard to do. For the same reason, the UK group might not be understood in their true meaning. Therefore, it might dissolve the potential rich data from one single cultural context.

6.2.1.2 Focus group procedure

The focus groups were led by the principal researcher, who was responsible for moderating the focus groups. Also, a note keeper was present to assist every individual interview and to make sure everything was in position and no core questions were omitted. The focus groups were conducted during school and working hours. All participants for each focus group were invited to a quiet study room. Information and consent forms were sent out by email or given face-to-face before the focus groups started. Each focus group took between 50 and 60 minutes to complete. The participants were well aware that they were recorded anonymously during the procedures. The moderator asked the pre-designed questions, but, in some case, the sequence of the questions might be changed because of the flow of the conversations. Nevertheless, all questions were covered (note keepers made sure this happened). The participants did not need to answer all of the questions. They were free to participate if the question appealed or they could respond to someone else's answers.

From the previous results, it has already been revealed that women in STEM still hold implicit and explicit gender-science stereotypes, but less strongly so than females in non-STEM subjects. Chinese female students showed a much higher gender-science stereotype than their UK counterparts. As I would like to explore why they have these gender-science stereotypes, I need to know why they initially became interested in STEM subjects. The main question is how it is possible they are studying STEM and that they hold gender-science stereotypes at the same time. Stereotype formulations are influenced by so many factors. In this case, the most relevant factors might be cultural differences, experiences of STEM, role models and key issues of STEM (see Chapter 4). So, based on the results obtained in phase one, coding was implemented using different methods in order to answer the questions above. In this attempt, the coding process involved looking for patterns, filters and anything heuristic or innovative in the manuscripts (see details in next chapter for an introduction to codes and coding).

The aim of my research (phase 2) was to investigate the choices and barriers to STEM study and career for females. Furthermore, it aimed to explore the underlying features/ factors which have impacted the educational trajectories to date, and future career ambitions, of women studying in STEM at the post-graduate level, and further to identify any coping strategies they employed to overcome gender-science stereotypes, and barriers to STEM participation. Lastly, it aimed to identify differences between the two national groups. Focus groups aims summarized below:

1. To explore the educational journeys of women studying STEM at the postgraduate, Ph.D. researcher, level.
2. To specifically unpack their experiences of gender-science stereotypes over their educational trajectories.
3. To elucidate the challenges and barriers for women who have successfully negotiated the education system to research at the postgraduate level in STEM.
4. To elucidate factors facilitating and positively influencing their successful pursuit of academic STEM in Higher Education (including the role of significant others: role models, media or parental influence).
5. To disaggregate some of the cross-cultural aspects of gender-science stereotypes from women studying and researching PhDs from the UK and China.
6. To model some of the cross-cultural barriers and facilitators for women studying and researching PhDs from the UK and China as critically applied to the ‘Leaky Pipeline’ analogy up to the level of PhD level achievement.

Thus, open-ended (discussion) questions (see Appendix A) were developed in the focus groups to explore the kinds of experiences, factors or role models might drive women’s interests in STEM, including interest in STEM subjects, STEM-relevant experiences, parents’ education or working in STEM, and role models in STEM. For the consideration of women’s situation in

STEM and to further reveal the explicit gender-stereotypes held by others and the implicit gender-science stereotypes held by STEM women, I also developed open-ended (discussion) questions (see Appendix A) relating to their own stereotypes and what difficulties they had met in pursuing a career in STEM.

To the questions for the two focus groups, extra questions were added for the Chinese group about the differences between the two countries in terms of their experiences and feelings as women in STEM. This could help develop a deeper understanding of the differences for cross-cultural comparisons. Moreover, when it came to the interviews with the Chinese women in the STEM field, besides comparing the two countries, the questions also concentrated on their personal experiences, their characteristics relevant to STEM, and their changes after becoming experts in STEM fields, to explore the commonalities in their characteristics and experiences as well as the cross-cultural differences.

Examples of questions used in the focus groups and interviews include the following (see Focus Group Protocol and Themes in Appendix A): Role model affects your career choice (general)- answer: who and how? According to what you know/see, what do you think of Chinese/UK females in STEM? Maths score? What other experiences have had an impact on your career?

6.2.2 Participants

Learning from the recruiting experience for phase 1, I realised that giving out flyers might not work well, especially for this population. I aimed to recruit only graduate research students (PhD students) to participate in the focus group. Instead, I asked at the specific postgraduate office to get straight to the point. I emailed the director of some STEM subject schools to ask if they could spread this news among their PhD students. This worked slowly, and I recruited no valid participants from this step. Eventually, from invitations and recommendations through friends, I was able to recruit enough numbers. The most difficult thing to manage was to arrange a convenient meeting time for each focus group. Time was spent negotiating their schedules. For example, a Google form was used to schedule a time for the UK focus groups and Chinese members of focus groups were gathered through a WeChat chat group. Finally, six Chinese female PhD students were gathered. One British participant did not show up, leaving only five UK female participants in the UK focus group.

The recruitments of participants were through several ways, one was asking around and setting up flyer in main buildings (i.e., library). In this case, some of the participants might be acquaintance or friends. If so, for the ethical consideration, I would enhance and ask them to keep confidential to their names and identical issues (see details in 6.2.7). Also, ask different school sent emails to STEM students would be efficient to recruit enough participants. The most challenging for this procedure was to get a time that everyone could attend. It's hard to do so, that made some extra participants were recruited in case someone could not attend.

The participants involved in the focus groups were highly involved in STEM fields. They were all female postgraduate research students (PhDs) studying in STEM in the UK and China. The six female PhDs participated for the Chinese focus group were from the following STEM fields: molecular cell and systems biology, biology-microbiology of fish, molecular cell and systems biology, quantum theory, virology, general practice-medicine; the five female PhD participants in the UK focus group studied the following subjects: physics, mathematics and statistics, health and health incoming and health technology assessment (HTA). Information of each participant can be found in the *Table 10-6.1* below:

Table 10-6.1: STEM subjects of participants in focus groups

Focus Group	Country	Pseudonym	Subject/Field	PhD year	Ideal job
1	UK	Danni	Computational Imaging (Physics)	1	Research and development in a company
1	UK	Jessica	Mathematics and Statistics	2	Health Statistician
1	UK	Helen	Statistics	1	Lecturer/Statistical Genetics
1	UK	Gloria	Health Incoming and Health Technology Assessment (HTA)	2	Clinical trials cost (effectiveness)
1	UK	Eva	Health Technology Assessment (HTA)	2	Health economies at university or in the NHS
2	China	Kate	Molecular cell and Systems Biology	3	Researcher/Teacher
2	China	Jane	Biology-Microbiology of fish	2	Marketing specialist in company
2	China	Linda	Molecular Cell and Systems Biology	1	Researcher/Teacher
2	China	Heather	Quantum Theory	2	Researcher
2	China	Susan	Virology	2	Researcher
2	China	Rachel	General Practice - Medicine	3	Researcher

6.2.3 Data analysis: Thematic Analysis (TA) for Focus Groups

Once all transcription had been completed, it was organised and analysed using thematic analysis (TA) for the focus groups to identify themes aligned with the research questions. According to Braun and Clarke (2012), thematic analysis is a widely used analytic method for ‘identifying, analysing and reporting patterns (themes) within data’ (p. 79). The process of thematic analysis for this study basically conforms to a six-step guide suggested by Braun and Clarke (2012): ‘1) familiarising myself with my data; 2) generating initial codes; 3) searching for themes; 4) reviewing themes; 5) defining and naming; 6) producing the report’ (pp. 86-93). Accordingly, the analysis started by thoroughly reading the full transcripts to achieve an overall impression of the respondents’ motivations and the factors that influenced them to pursue a STEM career as a woman.

The focus group and interview data were then coded using manual transcriptions first, marking and naming selections of text within each transcript. I opted not to use any software to help me with the transcript in this first step because it was a small-scale study, and it was too overwhelming for the first-time analysis (Saldana, 2009). Following Saldana’s (2009) advice, manuscript coding was rather practical and efficient for my case, as I was not abstracted by the software, and I was able to obtain better perspectives from the raw data. I tried to touch and explore the data in different manners by myself, such as by highlighting the data, reading them for different purposes and using fresh hard copies every time I read them so that I could extract as much information as I could. When the initial codes were fairly settled from the hard copies, and the abstract information had become “data”, I transferred all the codes into different themes on the computer (details will be shown in Chapter 10). This process of coding represents ‘the most basic segment, or element, of the raw data or information that can be assessed in a meaningful way regarding the phenomenon’ (Boyatzis, 1998, p. 63).

The next stage moves towards analysing those lists of produced codes and organising them into hierarchies. Specifically, this process focused on exploring the potential connections between codes, and between themes or subthemes, and the ways of sorting them into an appropriate broader level of themes. As explained earlier in this section, the themes (or subthemes) were identified and coded in an inductive way. Therefore, the themes identified are perhaps more focused on the data itself rather than the researchers' theoretical interest or engagement with the quantitative findings at this stage of analysis. In addition, such analytical processes involve repeated and careful reading of each data item until all relevant text was coded. Next, the collated extracts were reviewed to see if they could be merged into a reasonable category. The categories are then assumed, as Bryman (2016, p. 84) describes, to be 'saturated', meaning that sufficient information about what is of interest and relevance to the research topic has been achieved.

6.2.4 Ethical Issues in Focus Group Research

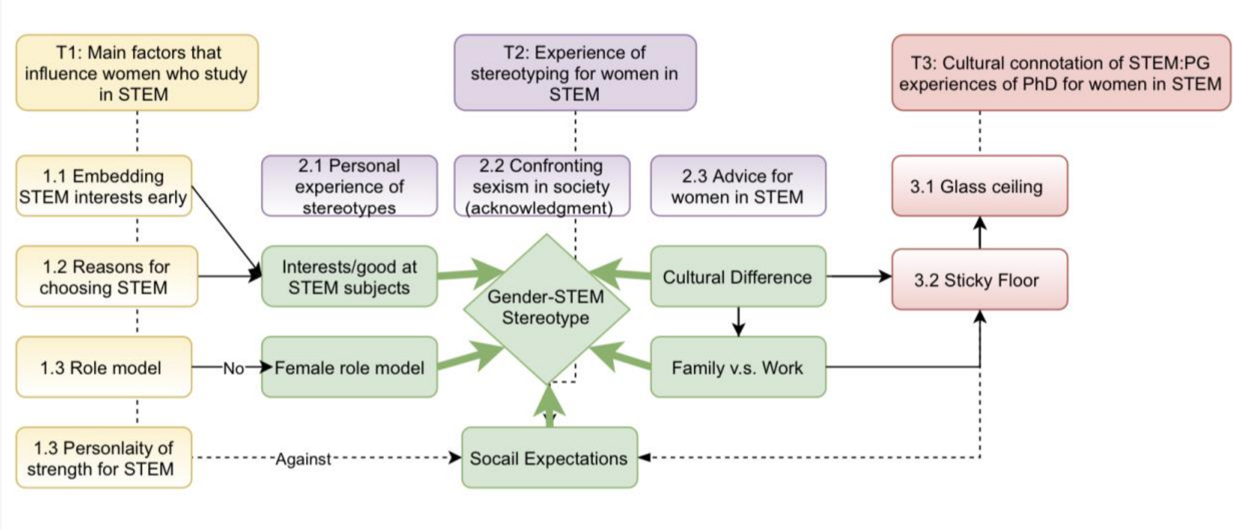
Ethical issues across the whole research should be taken carefully, except the translation issue for both focus groups and interviews, some specific ethical issues must pay attention in focus groups. Firstly, the focus groups were recorded throughout the whole process. These recordings will be kept safely and only be used by the researcher and supervisors for reviewing and analysis. Additionally, as the translation issue mentioned, three Chinese-English frequent college (one of them was recorder in the focus groups) to make sure there was no translation misunderstandings for the final codes which used for analysis.

If participants changing their mind and deciding to leave and the focus groups is possible. They have rights to withdraw whenever and wherever during the focus groups. If this happens, stop the discussion, and take participants to private space. Check the participants if she is okay and well. Get in touch with her right after the focus groups. Then I should consider it this happens and what to do with the data. there is no satisfaction solution in this case, withdraw part of the data will disturb the whole group data. It could not be accepted by psychology ethics codes with no consistence (e.g., The Ethics Committee of the British Psychological Society, 2021). the only way is to lose the whole group. Another essential consideration in focus groups is confidential, which is easily broken by others in the groups when discussed (Liamputtong, 2006). Before starting the focus group, this needs to be highlighted in the participants. No identify individual words in any counts, before and after the focus groups.

6.3 Focus Group (Study 2) Findings and Results

Thematic Analysis capture three main themes about the experiences of being women studying and working in STEM field across the UK and China as follows: (1) Main Factors that influence women who study in STEM, (2) Experience of stereotype for women in STEM, (3) Cultural connotations of STEM PG experiences: experiences of the PhD for women in STEM. All the themes, sub-themes and their relationships are in the *Figure13-6.1* above. On the one hand, some features came from those themes also stimulate forming Gender-STEM Stereotype, which highly prevent women from STEM career. On the other hand, the Gender-STEM Stereotype lens offers an opposite understanding of women maintaining participation in STEM fields. When designing the protocol of the focus groups, these possible influential factors came up in the literature review and the first stage of this research (see Chapter Three). Women in STEM might have a curial moment for career decisions, special reasons, role models and characteristics to inspire them to pursue a career in STEM (see Chapter Two). Alternatively, they may have received a family influence on their growth path without noticing directly. Certain barriers and difficulties might also have a positive impact on their careers. In this way, the focus groups allowed the women as a group to share their group perceptions of their successful STEM journeys to imminently achieve PhDs in their chosen areas.

Figure 13-6.1: Focus Group Themes



Based on research purposes, I transferred codes into five key features that might have contributed to Gender-STEM stereotypes across three themes: *Interests/good at STEM subjects* which driven from theme *1.1 Embedding STEM interests early* and theme *1.2 Reasons for choosing STEM as career* explore partial reasons and timings for choosing STEM as career (internal and external motivation); *1.3 Female role models* that affect their choosing STEM as a career, with few female *role models* found; additionally, some *1.4 characteristics of personality might be related with STEM* fields. On the path of STEM career, women might be experiencing stereotypes associated with STEM, which importantly explicitly discussing *2.1 personal experience of stereotypes*, to realize that *2.2 confronting sexism in society with their acknowledgement* and *2.3* sent some *aspirational advice* from them *to women* would step into STEM fields. Different obstacles show when women purse a higher career in STEM fields from different nations, which *Cultural differences* mattered and occurred to *3.1"Glass Ceiling"* and *3.2 "Sticky Floor"* to the UK and Chinese group, respectively. *Work and family* balance is real world worry as female researchers and other female family roles; Theme1, theme 2 and theme 3 might all challenge ***social expectations***, which doesn't meet social expectations for women on many perspectives. Social expectations might the main influencing factor and barrier from society when women pursuing STEM careers. Overall, the thematic analysis suggests five factors which might develop or inhibit Gender-STEM stereotype formation, and a range of experiential factors leading to promoting and maintaining interest in STEM educational goals. Each factor will be narratively elaborated within themes below presenting exemplar quotes for themes and sub-themes which summarise the group as a whole, identifying any conflicting messages, and finally untangling cross-cultural differences in the way these themes are manifested in the two groups.

6.3.1 Theme 1: Main Factors that Influence Women who Study in STEM

The first theme emerging from the focus groups was that main possible factors have an impact on women who work in STEM. As an overcharging themes to describe main features that have an impact on career decision in STEM fields, some main and common factors are outstanding from others. Some features come from those factors that might affect their attitude and format Gender-STEM stereotype will be addressed accordingly.

6.3.1.1 Theme 1.1: Embedding STEM interests early

When asked about when they had first become interested in STEM subjects, not all of the participants could pinpoint a particular moment. However, most of them stated that they had always loved STEM subjects since they were little. Also, there does not seem to be much difference between the two nationality focus groups; only variations in terms of the further reaction and reasons for STEM interests, which will be discussed in the next section. In the UK, the girls started to show an interest in STEM subjects and then they developed more specific interests in some subject areas. The following quotes highlight their interests in some specific subjects: “I was always interested in maths and sciences at school.” (Helen, PhD in STEM, UK, Appendix C, line13; see also Danni and Jessica). Similarly, in China, most of the participants had also showed an interest in STEM subjects since they were little: “I showed interests to STEM when I could read.” (Kate, PhD in STEM, China, Appendix D, line 2; see also Jane, Linda, Heather and Susan).

In the UK group, the women recalled their interest in STEM subjects as they grew (in primary school or beyond). It seems that not much could affect their love, and they received *encouragement and support from teachers. "...I never had this thought, and I was very lucky that I had very good teachers at high school and very good supports that around me. I was always to encourage to do well and studied hard. And I was never told that I couldn't do anything." (Jessica, PhD in STEM, UK, Appendix C, line 23-26;* see also Helen in Table)

Whereas, *in the Chinese group, they found little support or encouragement from society. In fact, people tended to think that girls studying STEM subjects was rather strange and not popular at all. "...when I was in primary school, if you participated a math competition as a girl, everyone would stand up and applause for you, I found that rather confusing to me (my understanding was that people found this strange at that time) ...I was doing great both at physics and English before I went to the university, but my teacher back then strongly suggested me to be a translator rather than doing anything science...she told me that it's better to be a translator as a girl in the future...it was more stable for girl." (Jane, PhD in STEM, UK, Appendix D, line 30-34).*

I can see that most of the participants had an early, and perhaps even 'natural', interest in STEM-related subjects when they were quite small, and for most this was encouraged at a young age by key adults- such as teachers or families, but differences between the two cultural cohorts emerges in different feedback from their societies when they started thinking about taking up STEM as a career. The reasons why they chose STEM as a career might help us understand these differences better. Hence, I will discuss these reasons in the following sections.

6.3.1.2 Theme 1.2: Internal and external motivations for studying STEM

The reasons for choosing STEM as a career vary between individuals, but most began out of their own interests in STEM, and enjoyment of STEM-related subjects. The very nature of STEM attracted to them; but this alone does not appear to be strong enough to keep them on this STEM path into skilled career pathways. What I am concerned with then, is 'why' and 'how' they ultimately chose STEM as careers. There are distinct features between the UK and Chinese groups, in this respect.

The reasons why STEM attracted to them in the first place appears very 'natural'[12], and this was the basis on which most chose STEM as a future career "Because you can apply it to real life... but biology was something that you can relate to life." (Jessica, PhD in STEM, UK, Appendix C, line 21-22). Similar reasons emerged from the Chinese group, who viewed STEM as "practical" and related to life. "....as the STEM subjects needs more operation, such as experiments. I am interested in these kind of things...I wanna try every single experiment in the book." (Linda, PhD in STEM, China, Appendix l D, line 5-7; see also Susan). For some of the Chinese women, their interest in STEM grew easily and effortlessly: "Once (I was a child) I found animals interesting, I didn't know it covers a wide range of subjects...so I simply linked animals to biology...I went to university studying biology...I found infection really interested in my master and found microorganism interested in PhD. That's my natural path of STEM." (Jane, PhD in STEM, China, Appendix line D, line 41-44). This suggested a strong internal motivation for studying STEM, and for setting STEM-related career goals. However, this appears to be more consistent in the UK group.

The differences between the two groups largely emerged when considering why they continued to focus on STEM as they progressed through their educational journeys. In the UK group, the women were attracted by the nature of STEM and their own interests had remained alive and fuelled largely by internal motivation, but with external support. More specifically, they frequently mentioned their encouraging teachers that supported them to go further and how they encountered few forms of discouragement in the environment in which they grew up. "I made a choice. It's different like it's a third career- followed my own interests that how...kind of swim from what kind of things primely doing because there is an interesting context." (Kate,

[12] The 'natural' here in the context means they learn math easily and effortlessly.

PhD in STEM, UK, Appendix line C, 92-93; see also Linda). Although specific role models are explored in the next section it is nevertheless interesting to note the presence of reinforced internalised interest in STEM with external positive reinforcement largely reported through the school experience.

By contrast, when the Chinese women discussed starting to show an interest in STEM subjects, as highlighted in the previous section, they felt they were treated differently because "normal women" were not expected to develop this internal interest in STEM study. They largely said that they chose their subjects more as a coincidence ("fate"), and in this sense the external factors were seen as chance at school rather than through positive external reinforcement of say teachers. What is worth noting here is the impact of the Chinese College Entrance Examination[13]; "I was intended to learn chemistry, but I had lower scores in the Chinese College Entrance Examination, so I had to choose medical science. But I quite like it now, it suits me." (Linda, PhD in STEM, China, Appendix line D, 49-51; see also Heather and Susan)

Some Chinese women chose STEM, not for internal motivations of interest but for anticipated external rewards, such as monetary gains through better occupation options: "I am interested with every subject. when I choose between Humanities and Science (& Engineer), I chose Science and Engineer, because within these areas, I have more options of jobs in the market." (Kate, PhD in STEM, China, Appendix D, line 8-9). However, some of these Chinese women

[13] Chinese College Entrance Exam: for this exam, students are divided into two classes and taught different levels of humanities and STEM subjects from the second year of high school. They have the same compulsory subjects: Chinese, maths and English, as well as two sets of subjects from which to choose from. STEM students learn biology, chemistry and physics. These three subjects are at a higher level than in the classes of the humanities. They also need to study history, geography and politics at a general level. All the students will have a standard level exam testing what they have studied at the end of the second year of high school. If they pass it, they only focus on STEM subjects from then on until the exam. As a result, students in STEM classes tend to have a wider range of university choices and better working conditions in the future.

in the focus group originally preferred Humanities, and therefore the internal motivations were completely absent, and external motivations prevailed: “I think I am better at Humanities... but I am doing life science because of the Chinese College Entry Examination, but I am still having dream of Humanities subjects. you could have something to dream of and doing your own business at the same time.” (Kate, PhD in STEM, UK, Appendix line D, 10-13)

In the Chinese group, most of the women had to make a choice at a specific point along this path. Most of them had received discouragement regarding their choices. Only a few had met some encouragement from teachers and parents. The further they went, the more confusing and frustrating their paths became. Here is one of the participants’ statements in this regard:

“when I was young, I was better at Humanities subjects than Science subjects. I was good at languages. But when I had to choose between Humanities or Science in High School, my scores were quite even... I decided to choose Science...because I thought Science was hard to be self-taught and I could do learn Humanities anytime by myself in my life...but it’s hard to learn science that way... everyone recommended me to choose Humanities instead of Science, they ignored my potential in Science...the same thing happened before I chose my subjects in the university, my high school teacher highly suggested me to learn translation instead of physics...she told me it’s good for a girl to be a translator in the society...because it’s easy to find a job and get married...I am so grateful of not choosing translation!” (Rachel, PhD in STEM, China, Appendix D, line 19-24).

It seemed that the focus group of Chinese women in STEM reported two different paths, either an internalised motivation to study STEM all along, or via a humanities background by which they chose STEM as a subject of study for external motivations to achieve successful career goals, or some courses balanced both motivations, but many of them changed or even supressed their original thoughts about embarking on a STEM path. The reasons given were various. Individually, they began to favour different subjects. Sometimes, they did equally well in humanities and science subjects, so their choice depended on their potential occupation. Objectively, the Chinese College Entry Examination forced them to ‘pick a side’. Eventually, they found their way to STEM after making these choices and STEM became their career, thus the internal motivation for STEM study is less prominent in the Chinese focus group.

6.3.1.2.1 Social expectations

Their love for their subjects was even more evident when the participants discussed their own experiences and feelings of being a woman in STEM. Accordingly, it seems that both groups had a natural interest in and love for STEM subjects when they were children, but this interest began to take different directions when they grew a little older (they continued show interests in STEM) to meet their different social expectations, which might affect their attitude towards STEM fields and format Gender-STEM Stereotype.

6.3.1.3 Theme 1.3: Few, but significant, same-sex STEM role models (often familial)

When talking about their paths to STEM, it seems that, at times, significant people had an impact on the participants' decisions to choose STEM as a subject of study and potential are for future career goals. These are termed same-sex STEM role models (SSSRMs) or their career role models. The Chinese women grew up in a rather discouraging environment, in which people had either no or a negative impact on their STEM careers. However, when they do remember the encouraging persons and models that help them step into STEM fields: "My mum has an impact on me, she was learning science (physics chemistry). She told me something about science when I was little." (Rachel, PhD in STEM, China, Appendix D, line 73-75). Parents could be the most influential model for children in many ways for their career in the future. Here her mom as a parent and a ***female role model*** for her. Furthermore, there were times when they also had a massively positive impact on them for make a decision, too. "… I found that's beneficial to me...when I wanna quit physics in university, my mother and one male teacher encourage me that have a significant effect on my PhD decision." (Rachel, PhD in STEM, China, Appendix D, line 76-77; see also Jane). Most reported having had no female role model around them.

In the UK, it seems that even when they had parents or friends in STEM, they seemed to indicate that they were less affected by them than by their own interests. Parents and teachers were discussed most often as sources of encouragement and support, again illustrating the primacy of internal motivations with relatively consistent external social support in the UK focus groups: “I’d say parents and teachers. I was just always, again getting the grades being the top of my class. Do myself...my parents and teachers have my back.” (Helen, PhD in STEM, UK, Appendix C, line 39-40). To add more encouragement for this STEM role model, cthe SSSRM was presented as influencing her attitude that help her make future decisions: “yeah so probably like for stem wise my day and physics teacher Dad, teachers and there’s a woman that I went to at the space school (inspired me) when I was 16. It’s the coolest person I’ve ever seen... She was like an engineer who worked on the system of spaceship. She wore six-inch stilettos and mini skirt and had long blond hair. Even still in STEM there are women that got different images that is absolutely fine, you sort of don’t actually get that message. You start to do necessary I was quite like She was like a breath of fresh air as a 16-year girl.” (Gloria, PhD in STEM, UK, Appendix C, line 55-61). However, in the Chinese focus groups, although same-sex role STEM models were discussed, a subtle difference between two countries on this role model. They were reported less often female role models found in the public or on the media in China, mostly people around them, teacher and parents, not even from grandparents and peers (in the UK, women could find support from peers and some grandparents). This might suggest that the Chinese older generation still hold these gender-STEM stereotypes influenced by the tradition and the same for the Chinese society (media and public).

6.3.1.4 Theme 1.4: Perception of Agentic Personality Strengths for STEM

This theme illustrates another factor of outstanding common factors reported from women in both groups for studying and working in STEM fields. In general, the women from both groups had quite similar opinions about the characteristics of a woman in STEM, some of which can be considered androgynous, such as having higher self-motivation and being hard workers, as well as being a good learner, a good researcher in a STEM field, and some could be considered as more communal (traditionally feminine) characteristics, such as always supporting each other, and having stronger networks compared with male colleagues. In the discussions, they spontaneously, and with pride, compared women with men in STEM, which illustrate they are aware of this gender-STEM stereotype from both countries: “We also had a good support system to each other. So, we study together, and we spoke everything to each other, we help each other. Which I think definitely help me. we are more willing to help each other.” (Eva, PhD in STEM, UK, Appendix C, line 217-219; see also Kate and Jane).

However, many of the traits attributed to STEM success could be perceived to be traditionally agentic (masculine) ‘doing’ characteristics of being strong, assertive (aggressive even), competitive “...they (men) are kind of like the Gatekeepers to our discipline- are mainly men they are kind of the seriousness around this kind of group ‘founding fathers’ of this discipline- it’s quite difficult...” (Danni, PhD in STEM, UK, Appendix C, line 189-192; also see in Jessica). and some Chinese women also mentioned that they had to “change” their personality characteristics to be successful as a STEM researcher, “the reason why I wasn’t too much getting involved into my college life was the teacher in the college accused of me not dress like a girl studying science! How should a girl like me (women in STEM) dress...very conservative: wear a collar shirt with no make- up on...intellectual equals conservative...if you put too much on how to dress up as a beautiful girl, you don’t have time to study hard..., But here (in UK), there is no such thing...you couldn’t judge people and tell what they learn from their appearances...there is no correlation between.” (Susan, PhD in STEM, China, Appendix D, line 174-181; see also Linda). The STEM subjects are highly associated with men in China, even appearances. To be successful in STEM fields, women would be expected as less feminine than other women in other fields.

Both groups generally believed that women had to be harder workers and more dedicated than their male peers: “I also found that the females I known work harder. The males I know no. I don’t know if that it’s because we are friends with females know them (personally)- we worked hard, twice harder because we felt we were very very very dedicated to definitely what we want to do really well. Because we felt a way of study dominated more than others.” (Helen PhD in STEM, UK, Appendix C, line 211-214). Also, she featured stereotype from male side: “The females in our course studied constantly so hard. Whereas, the guys were just showing off, not studying.” (Helen, PhD in STEM, UK, Appendix C, line 215-216).

Furthermore, the Chinese group discussed some common communal characteristics required to be a researcher: most researchers were peaceful, patient and had high psychological endurance because many studies are not under their control: “...especially in STEM field, you need to be calm and have a clear mind.” (Linda, PhD in STEM, China, Appendix D, line 109; see also Kate and Jane). Other non-gendered personality characteristics that they think motivated them in a STEM career were addressed: “I think you need the Intellectual curiosity.” (Helen, PhD in STEM, China, Appendix C, line 226). Furthermore, “...also, emulation, you don’t want to lose, don’t admit defeat...this spirit could help you keep doing research.” (Susan, PhD in STEM, China, Appendix D, line 132-133). Therefore, it can be seen, that although many of the perceived successful traits for attaining a PhD in STEM study may be considered non-gendered, and interestingly, both communal and agentic characteristics were valued for STEM success, it appears that women still perceive the needs to work longer and harder than male colleagues to avoid confirming any negative stereotypes, and more interestingly the agentic characteristics, and in particular the need to be ‘strong’ and ‘assertive’ was at odds with some women’s personality, to the extent that some Chinese women felt they needed to change themselves to fit with the ‘habitus’ and ethos of the labs within which they studied.

6.3.2 Theme 2: Experience of Stereotyping for Women in STEM

This theme will discuss the experiences of stereotyping of women in STEM and explore the different experiences of the two cultural focus groups and why they think it occurred. According to their statements, I obtained main findings about their personal experiences, their acknowledgement of sexism in society, and their advice for women in STEM based on their experience.

6.3.2.1 Theme 2.1: Cognitive dissonance around personal experiences of stereotypes

Most of the women explicitly stated that they had not encountered any negative gender stereotyping in terms of the subjects they were studying, however as can be seen in the manifestation of the sub-theme above, this does not seem to be the lived reality. Despite explicitly stating they had no personal experiences of negative gender stereotypes, some of the women in the UK group went on to report/ describe having experienced stereotyping in some everyday occasions. Wherease, rhe Chinese sub-sample spoke more explicitly about the stereotypes of the lifestyle of women in society contrasting with women in STEM and the differences between the two countries in terms of gender stereotyping, including appearance bias and needing to change the way they dressed, spoke and behaved. But ‘dissonance’ appeared in both groups as the effects of such stereotypes on oneself as an individual studying and working in STEM were generally not acknowledged to have affected any of them individually.

In the UK group, they stated that when they met someone new, they found themselves in rather delicate situations, for various reasons: “I’ve often got (stereotype)... if I met someone new and ask what’re you doing. And I say I’m doing a PhD in Stats. It’s like “really?” (Enhanced tone) why you study a discipline like that! they are like quite shocked about what’s I do and almost put off. They thought it’s really boring about what you do. They sort of turning off and passed it.” (Helen, PhD in STEM, UK, Appendix C, line 146-149; see also Gloria).

Some of the participants in the UK group stated that the stereotype depends on personalities, and not only on their gender or on the subjects they studied: “I think it’s more like a personality thing. I don’t it’s a female thing or gender. When you meet people in your field, and you are doing the same they do. you’re a happy, smiling person...That could mean when they face with the same situation, they react diversely because of their different personality.” (Jessica, PhD in STEM, UK, Appendix C, line 157-158).

Some stereotypes come from the subjects they were studying: “We’re statisticians so people’s reaction like think that’s so boring-it’s just counting numbers all day long. People not understating what we do. so even a male will get the same stereotype as we do. I don’t think it’s because I am a female. But in our department, we’re a bit of a laughingstock cuz we are more different than others in the department because we make tea.” (Eva, PhD in STEM, UK, Appendix C, line 164-168).

All of these comments combined with another stereotype faced by women in STEM: they were female and PhD researchers. When people stereotype what they studied, most were judging the fact that they were female PhD students. “I think that’s because I stay in the department and never speak someone above me. I think they think the exact the opposite. I hate saying I’m not your average PhD, I think I am completely but it’s not from what people expect. Sometimes you are coming like you’re all smiling and happy, and they don’t know how to do with it.” (PhD stereotype) (Jessica, PhD in STEM, UK, Appendix C, line 152-155; see also Helen).

In the Chinese group, the participants encountered some stereotyping of the appearance of women in STEM. This could be viewed as rather conservative: “the reason why I wasn’t too much getting involved into my college life was the teacher in the college accused of me not dress like a girl studying science! How should a girl like me (women in STEM) dress...very conservative: wear a collar shirt with no make- up on...intellectual equals conservative...if you put too much on how to dress up as a beautiful girl, you don’t have time to study hard...if a girl grows up in this kind of environment, she will definitely be affected and changed. But here (in UK), there is no such thing...you couldn’t judge people and tell what they learn from their appearances...there is no correlation between.” (Susan, PhD in STEM, China, Appendix D, line 174-181; see also Linda). Further, they mainly agreed that the negative stereotyping of Chinese women in STEM was much stronger than that faced by women in the UK.

Even with less encouragement and approval, I found some strong awareness of gender-STEM stereotypes in the Chinese group: “I would like do as good as boys and get applause for what I was better at doing science...why everyone (my parents and teachers) persuades me to study Humanities subjects? Even though I was slightly better at English and Chinese...I might be in rebellious stage at that time, I was better at science subjects than most of the boys in the class, why I had to choose Humanities subjects?” (Rachel, PhD in STEM, China, Appendix D, line 25-27, 30-31) Rachel hereby feels no one paid them any attention or gave them any encouragement, which she acknowledgement the gender-STEM stereotype situation and challenge the environment against such social expectations. Therefore, in this sense, the dissonance is actually greater in the UK, with far less acknowledgement of the existing and effects of negative gender-stereotypes. But both samples to some extent indicated that these affected ‘other girls’ and women, but not them personally, they were ‘strong’ and had been immune to the social effects of stereotypes even when they were perceived.

6.3.2.2 Theme 2.2: Acknowledging but not confronting sexism in STEM research settings

This theme explores experiencing sexism when pursuing their careers from both nations. Besides the Chinese women reported further experiencing sexism and will be extended in detail in the interview findings.

In the UK group, it was found that some gender stereotypes were common in certain subject-specific areas in STEM: “I think in physics if you think what you do, female researchers are all health physics I look at what you do- There are areas physics theoretical physics and you have these higher movement of females towards health physics. Sometimes I do think I have the knowledge of I hold that stereotype. I don’t think it’s right- dispersion of women to health versus harder theoretical because there are health physics (women) one part and the other harder physics the other part”- (some hard-core physics should be male cus they used to all male domain area.) (Jessica, PhD in STEM, UK, Appendix C, line 172-177).

The reason might be the image that hardcore physics should be male because people are used to an all-male area: “pure maths very little female, maths and statistics in hard maths and more in applied Maths... the theory comes from the men, we are going to apply it...I think it’s difficult one. because Historically, men (always) would be, we see more men are on the theoretical side, men did come up with theory.” (Helen, PhD in STEM, UK, Appendix C, line 178; 179; 198-199).

In some conditions, the gender-stereotypes related to STEM subjects are more obvious which related with men dominate in higher position in STEM fields, and women are still showing weak confident: “I went to a conference in Glasgow for Health Economics- a lot of middle-aged men- Americans- in higher positions. It’s very obvious that ... cuz we’ve got used to it. I don’t know it is the Americans or the older institution group. So, it’s quite noticeable because all our directors were women. The main people in this group are the middle- age and come across as very confident. Although there are women at that level (they were weaker) at these group.” (Jessica, PhD in STEM, UK, Appendix C, line 184-188).

Therefore, women were perceived as not treated equally in STEM fields, but overall the participants felt that they had growm accustomed to this. The participants gave reasons for this and why they view men as being more confident in this fields: “...they are kind of like the Gatekeepers to our discipline- are mainly men they are kind of the seriousness around this kind of group ‘founding fathers’ of this discipline- it’s quite difficult...Emma's (one of the advanced achieved women in that field) just as well-published doesn’t get the same profile at this conference as they do.” (Danni, PhD in STEM, UK, Appendix C, line 189-192; also see in Jessica).

Even in this situation, men’s privilege exists, the participants in the UK group believed that this will pass, and that the future is promising, full of hope, even though uncertainty remains:

“It's only really been very recent year that women have had the chance to do the research. By very much point the first research has been done. So, there is not, still unpacked been made, but there is not the main (theories) been made. They’ve already been found. So, women, It’s just circumstances because just traditionally men.” (Danni, PhD in STEM, UK, Appendix C, line 199-201; also see in Helen).

Therefore, in essence, the prior sub-theme shows a cognitive dissonance, this theme rather shows a behavioural dissonance, and without placing blame or promoting a deficit model, many participants felt that inequality and even overt discrimination was something they would need to deal with until future generations had fought against these issues. It may be that in both focus groups, there was an implicit acknowledgement of social sanctions for challenging the ‘status quo’, and that women who speak up against sexism in the research may be labelled as problematics ‘feminists.

6.3.2.3 Theme 2.3: aspirational advice for women in STEM (sending the ladder down behind them)

This theme is about that how they would encourage women when they see potential women interested into STEM fields. The two groups provided advice for girls/women who might be interested in STEM. They both greatly encouraged girls who have a potential interest in STEM fields. The phrase “be true to yourselves” was frequently used in this context.

The women in the UK group advised girls not to be influenced by the public: “What you go for what you want to achieve.” (Jessica, PhD in STEM, UK, Appendix C, line 233)., Also, follow their own interests instead of being affected by what girls do and what boys do. As a result, “What you’re interested in then do it.” (Jessica, PhD in STEM, UK, Appendix C, line 234). The aspirational advice in the UK was largely around individualistic tendencies to ‘follow one’s heart’ and internal motivations of interest, however “Go for it” Was the sentence most used in the Chinese group. Their advice was more in the form of group-based encouragement for the next generation of women STEM researchers.

Yes for the Chinese sub-group there were some concerns and contradictions: “Brave and be yourselves. Let it be...” (Heather, PhD in STEM, China, Appendix D, line 258; also see in Jane and Rachel). As well as acknowledgement that , in some conditions, women cannot help but be influenced by social environments, such as family: “Don’t be affected too much by family issues [expectations of the family]. Let it be!” (Kate, PhD in STEM, China, Appendix D, line 275). According to their own experiences of studying abroad, some of them encouraged girls to do similarly and go overseas not only to broaden their horizons, but also to escape from these women unfriendly working environment. “go outside (study) when you get chances” (Linda, PhD in STEM, China, Appendix D, line 259).

For the Chinese women, underlying the aspirational advice, and the desire to support future women studying STEM, there was an entrenched awareness that family expectations appeared to continue to be major issues for Chinese women in STEM, as I will discuss in Finding 3. The participants also interestingly provided marriage advice[14]: “you will find someone when you reach to a quality level, you won’t find him If you stuck where you are now.” (Susan, PhD in STEM, China, Appendix D, line 271-272). The aspirational advice to support future women to ‘come up the STEM ladder’, seemed very much individualised and internalised in the UK focus group, but in the Chinese group such aspirational advice was accompanied by practical suggestions for negotiating complex family pressures, including even future marital partnerships and motherhood demands.

[14] This refers to the special context of “left-over women” in China, to which we will refer in the next section 10.2.3.1.

6.3.3 Theme 3: Cultural connotations of STEM experience: experiences of the Phd for women in STEM

The final theme tries to capture the most outstanding differences between two nations in the focus groups. When the discussions went deeper, the women from both groups showed their concerns about being a female PhD student in STEM, reporting that they felt ‘intimidated’. Also, both groups stated that they had experienced some difficult situations as female PhD students and as female STEM PhD students. However, the two groups discussed the issue from two different perspectives. The Chinese female PhD students suffered from the pressures of their conventional culture and their families’ expectations. However, the female PhD students in the UK were much more concerned about the promotion difficulties they faced in their careers. This might be due to a “sticky floor” or a “glass ceiling”[15]. Those two terms are often used to discuss the hiring and promotion problems faced by certain social groups.

6.3.3.1 Theme 3.1: Glass ceiling

The British focus groups’ over-arching experience could best be described by the phenomena of the glass ceiling, in that they perceived fewer and fewer women as they progressed through their educational journeys and approached careers in their specialisms. In the UK, women also face problems pursuing a PhD researching STEM and ultimately a STEM career. STEM women are underrepresented in the higher level of the professions. Even in the UK the women reported not being able to find many female colleagues doing similar STEM research, such as female staff and post-doctoral researchers to act as aspirational role models: “the college is all women and the degree were all men. So it was all female colleagues down there as part of the system you get into that, I sort of find like the justification of these two situations are really hard to get over because I really love to be in this kind of all female environment which I didn’t expect and that’s the main reason why I’ve chosen to do then as part of my degree it’s becoming

[15] The term “glass ceiling” refers to an invisible barrier that blocks women (and minorities) from achieving developing their STEM careers to a higher level. The alternative model is that the glass ceiling is really a “sticky floor” that results from cultural traditions and family expectations.

more and more weird -was almost all men- hard to be open in that kind of environment- (you) get a stuffy response (weird, weird).” (Gloria, PhD in STEM, UK, Appendix C, line 129-134).

Women in both groups reported that they tended to support each other (10.2.1.4); but at the same time the UK focus group seemed to convey that they feel “alone” in STEM fields and struggled to see future expectations in these fields: “It was difficult to see myself succeed in doing that because everyone is looking like not me (enhance tone).”(Gloria, PhD in STEM, UK, Appendix C, line 124-125).This observation might be because they did not have many female role models in this field: “I was doing my master’s in electric engineering that was quite difficult. Because physics might be 60/40 split male and female? But in Electronic engineering is like 90/10 per cent it’s like the older men and from a different era.” (Gloria, PhD in STEM, UK, Appendix C, line 120-122). In this sense, that barriers to progression through PhD research and into STEM careers appeared to increase exponentially at this highest level of study, the external support they perceived throughout schooling thinned and they struggled with lack of significant role models, particularly struggling in the ‘chilly climate’ of male-dominated specialisms.

6.3.3.2 Theme 3.2: Sticky floor

The Chinese focus groups’ over-arching experience could best be described by the phenomena of a ‘sticky floor’ as opposed to the glass ceiling, in that they perceived the most resistance from conflicts with their familial and cultural links, rather than resistance from their educational environements or colleagues in their careers in their specialisms. In China, the participants felt there were stronger negative stereotype of women doing PhDs (or even women studying degrees in higher education), as to some extent this is seen as in conflict to gendered family role fulfilment. Girls are underestimated and often compared negatively with boys in the society. The women in the cohort felt that their Chinese male PhD counterparts were treated very differently. These women perceived social stereotypes and sexism emanating from- their home families and societies and for many this led to budding female researchers experiencing self-doubt, which may have a very negative impact on women with higher education qualifications in many aspects of their lives, such as marriage, family, work and networking.

For Chinese women researching for PhDs in STEM, several factors contributed to their experience of gender stereotyping, and its impact on their aspirations: “Not only they treat us (female PhD in STEM) differently, also they have negative stereotype to women with a PhD degree!” (Susan, PhD in STEM, China, Appendix D, line 190). Also, from traditional affect; “Women should not be literature too much!” (Susan, PhD in STEM, China, Appendix D, line 209). And these sex-stereotypes may make women doubt their abilities to undertake a STEM PhD: “Girls were convinced when they were little that they are not that smart as boys are. (I don’t think so) Actually, girls tend to do better at each subject. This kind of thoughts make most of the women think they could not achieve a PhD does not mention a STEM PhD (because they are not smarter than men, STEM subjects are hard.)!” (Jane, PhD in STEM, China, Appendix D, line 191-194).

These stereotypes may also have a significant on their perspectives of marriage. In China, women with a PhD degree are less popular when it comes to marriage. “...they doubt women are escaping from work; even they understand, women will be expected (ideally) to get a boyfriend, married or even have a child before they continue as a PhD.” (Linda, PhD in STEM, China, Appendix D, line 198-200). This situation contrasts with men wishing to do PhDs: “On the contrary, if men do a PhD, everyone encouraging and supported.” (Linda, PhD in STEM, China, Appendix D, line 200). Family expectations of girls adjust to these **social expectations**, thus a PhD degree for a girl is unwelcome to certain social status, such as marriage: “I’ve always been a good and nice girl to my families, and it turns out not to be a good and nice girl when I decide to do a PhD...at least, I need a boyfriend first to do a PhD.” (Heather, PhD in STEM, China, Appendix D, line 204-208; also see in Susan).

Thus, women are more likely to be judged within Chinese society according to their family functions than their UK counterparts, while their occupational status/ outcomes in traditional Chinese culture. As women should not be “higher” than men in any aspect, a higher education degree would apparently violate this rule. “... ‘there is no use to get a higher degree (for a woman), no one would take you as a wife in the future...’ in China, most of the women affect by these kinds of words and in a relationship, most of the women would sacrifice for their family and give privilege to the men.” (Kate, PhD in STEM, China, Appendix D, line 250-252).

When comparing their experiences in the UK and in China, the women reported feeling more respect for their work and their abilities in the UK. Moreover, in their relationships, men in the UK tended to be perceived as respecting women more. “Men (in UK) really respect women equally, in a relationship, they will consider which way is good for this relationship, to decide who works, who don’t if they need one to stay at home to take care of family.” (Linda, PhD in STEM, China, Appendix D, line 251-252; also see in Jane and Kate).

6.4 Summary and Discussion of Focus Groups Findings

In brief, key findings related to the factors that might affect women’s careers in STEM (i.e. timing, reasons, role models, characteristics, barriers). On the whole, both cohorts reported their interests in STEM from an early age; encountered few female role models; emphasised their “special” characteristics as good learners, as well as the need to be patient and have curiosity. The primary difference between the two groups was that in the as UK, girls were encouraged to continue their interests in STEM. However, in China, most of the girls were not encouraged to do so. Interest in STEM was found at an early stage or with no specific timing for Chinese women. These interests in maths or science always could be related with better performances in those subjects; for example, previous research indicates that maths performance improvement could have a positive impact on girls in many ways (e.g. interests, career choice; Gunderson, et al., 2012). Interest could also be fostered by receiving encouragement from parents and teachers; however, girls might not usually receive them, especially from teachers (Li, 1999).

In terms of participants' reasons for choosing STEM fields, the main factor influencing Chinese women's decisions related to the CCEE examination, which required them to choose a major from the STEM or the humanities categories. For instance, the privilege of women could get better grades at CCEE and college, not found in the job market (Cai, 2016). The reality of the job markets for the two categories is that STEM careers tend to offer an easier path to a relatively higher income (e.g. office work in STEM fields). The main reason for them not deciding independently about their career choices might be their relative lack of knowledge about their future careers or about the real pressures of job hunting in society. Furthermore, Chinese women focused on two main aspects when making career decisions: the work environment and their parents' (or others') suggestions. This was something that I had missed when I looked at the reasons or impact factors that might lead to Chinese women's attrition in STEM fields. It was somewhat of a surprise to find that women would remain in STEM fields for this very reason. That is, the reasons why Chinese women might not be able to easily make decisions about their careers could be closely related to the impacts of their families and society.

In relation to the impact of role models on women in STEM, Chinese women reported a lack female role models around them. They also shared concerns about the absence of female role models in top positions in STEM fields being one of the reasons why they might not choose to pursue a career or remain in those fields. However, this concern was not limited to STEM fields as it has generally been shown that women are underrepresented in all higher professional positions (Herrmann, et al., 2016). Previous research generally suggests that role models might have an impact on boys and girls and be particularly encouraging for girls (Latane, 1981). Girls' maths performances are found to improve when exposed to female role models, which is in line with recent research especially from teachers (Li, 1999), who found the female role models exposure for girls could improve academic performance increase the possibility of and the persistence in STEM fields. No direct link was found between female role models and women in STEM fields other than that exposure to female teachers in engineering classes would decrease boys' and girls' gender stereotypes regarding engineering (Catherine, Chelsea, & Jenny, 2017).

Unexpectedly, results suggest that although most participants experienced negative stereotyping for being a PhD, majority of them claimed that they had not experienced any negative stereotyping of women in STEM. In other words, it appears that participants experienced stereotyping for being a PhD, rather than a gender- or subject-specific-form of prejudice. This echoes the results of a study in which a Chinese researcher provided narratives about female and male PhDs and the subjects reacted normally and positively to male PhD candidates but expressed concerns about the abilities of female PhD candidates and suggested that it is not necessary for women to pursue education to such a high level (see review in Cao, 2019). Furthermore, in academia, female professors might express similar attitudes by doubting their own professionality compared with males (e.g. Eagly, et al., 2014).

On the whole, differences between the two groups stemmed from their different cultural backgrounds. For instance, a special issue emerging from the UK cohort was that women in STEM met a "glass ceiling" in their fields. That is, the main challenge identified was that men are privileged at the top of the professions in STEM fields, especially in some hard science-related careers. In contrast, the Chinese cohort encountered a "sticky floor" problem arising from the impact of traditional Chinese culture. That is, the obstacles they faced were mainly from their families or society regarding the gender stereotyping of women.

Overall, these findings extend the knowledge from the previous literature, which had largely focused on expectations regarding women's leadership in top positions, by providing a better cross-cultural understanding of women with higher education backgrounds, rather than just women in high professional positions. In the next chapter, I will wrap up all findings to correspond overarching aims and put into triangulated discussions.

7. CHAPTER SEVEN: PHASE TWO QUALITATIVE STUDY 3-INTERVIEWS FOR CHINESE WOMEN IN STEM AT EARLIER CAREER STAGE

This chapter presents Phase 2 qualitative Study 3 involving interviews with successful Chinese women working in STEM fields as post -doctoral researchers. It will begin with a description of the methodology (section 7.1, section 7.2, section 7.3 & section 7.4), analytical approach (section 7.5), followed by a discussion of research reflexivity (section 7.6) and results discussion (section 7.7 & section 7.8).

7.1 Methods

In the last chapter I discussed women studying in STEM fields at HE level from the UK and China, which achieved to find factors that might be influenced for women studying in STEM fields at HE level and argued that Chinese women might be facing much more influencing from “the sticky floor”. Based on the overarching aim 1 & 2, ***overarching aim 3***, which *Investigate in-depth the underlying factors influencing Chinese women’s decisions to pursue and maintain in high-level STEM careers in the UK, considering wider cultural and family influence on career progression and maintenance?* Then, semi-structured interviews (Study 3) are conducted with successful Chinese women all working in STEM fields as post-doctoral researchers. An interpretative phenomenon analysis (IPA) is presented for the in-depth career interviews. The purpose of these interviews was to explore how these women managed to follow their paths in their STEM careers, in order to uncover some of the facilitating and inhibiting factors to STEM career pursuit.

7.1.1 Research Design and Interview

The aim of the second aspect of qualitative research was to employ in-depth interviews to investigate the lived experiences of Chinese women working and researching in their chosen STEM fields. The last chapter discussed the focus groups, which attempted to partially answer the questions of factors positively influence Chinese women to study STEM at HE level, with the view to enter STEM fields and/ or promote their studies into Ph.D research in the UK. Also, from the previous findings of phase one, it was suggested that Chinese woman in STEM suffer much more gender-science stereotype issues than their UK counterparts. Moreover, from both phases of findings, as well as the literature, it appears that Chinese women are implicitly and explicitly more impacted with gendered STEM barriers, for instance from historical Chinese cultural messages, and the top-down and sudden feminist policies. Therefore, in this stage, I would like to know more about the background and experiences as to why some Chinese women may hold stronger gender-science stereotypes, and how barriers can be overcome for women successfully working and researching in their chosen fields. Therefore, this chapter lays out the interview methodology, aims and findings to explore underlying factors influencing Chinese women's decisions to pursue and maintain in high-level STEM careers in the UK, and identifying the key triggers points for career progression and maintenance.

The questions expanded not only on the participants' own experiences, but also the differences they observed across both country employment contexts, as they had experience of living in two countries. As this requires more in- depth methods, interviews could be used to encourage them to share their own experiences in a more comfortable way. One-to-one semi-structed interviews between the interviewer and the interviewee are the most widely used methods in qualitative research; but this does not mean they should be the default methods. However, interview is ideal method to gather detail data and information. Interviews were conducted to learn about trends of experience, in study 3, based on aims and what I found out in the previous studies, I would know more about detail information of Chinese women working in STEM fields. For example, I learned that Chinese parents have strong impact on Chinese women, but how exactly for their STEM career? Interview was applied in Study 3 to ask such following up questions in details and depth. Additionally, as what I desired in Study 3 were more focusing on Chinese women's experiences and pathways, the underlying story of their STEM career (e.g., how they made a decision to choose STEM). When it came to describe the explanation, experiences and how they made decisions, interview was method to understand the process.

These interviews were designed to specifically focus on Chinese women who successfully were working in STEM, to identify their pathways into STEM fields, and explore the impact of barriers on them in their fields. The interview questions should overlap with those of the focus groups but focus on the participants' educational and working trajectories and wider life experiences. These questions would ask follow-up questions, moving past the higher education stage of life, to get more details and depth regarding career achievement and persistence.

7.1.2 Interview questions and protocol

Given the underrepresentation of Chinese females in STEM fields, the women working in STEM fields could be considered to be successfully avoiding the typical conditions of gender-science stereotyping. Their experience and pathways could help us understand how they had been able to pursue successful STEM careers. Therefore, the aims of these interviews were as follows:

1. To explore specific experiences/characteristics that inspire Chinese women to pursue a (successful) career in STEM—this could be based on characteristics emerging in focus groups.

2. To more deeply investigate the educational and career trajectories of Chinese women STEM working early in their careers as researchers
3. To more widely contextualise these experiences when considering the role of Chinese culture on the successful female STEM researchers' different experiences in the UK and in China.

The interview protocol was developed using a systematic review of the literature. And the protocol was drafted for iterative development with the supervisory team. Once the protocol was agreed, I conducted a pilot test of the interview protocol on two female STEM participants (one from the UK, the other from China) (see Appendix B). Based on this pilot interview analysis, I slightly revised the order of the protocol questions (follow a timeline as they grow up) and developed additional probing questions (some suggestions the participants offered to other girls potentially interested in STEM). All questions and processes are presented in Appendix B. Field notes were also taken from observation in the field after interviews (e.g., sighs, pauses and sounds notes only).

7.2 Participants

Chinese women working successfully as post-doctorate researchers in STEM were chosen to be interviewees to provide rich and valid data, as women's underrepresentation shows at a higher level when progressing from postgraduate study into employ and the prior phases of data indicate that the internalised stereotypes, and extern barriers are more significant for the Chinese women in the sample. It’s hard to find full-time permanent research positions, working in Higher Education. Many excellent opportunities are given to international scholars to study and work in the UK, and Chinese STEM women found in the UK are likely to be excellent scholars (sponsored by the government) or very successful in their prior post graduate research (Ph.D.), to be able to continue a career in the UK. They therefore represent the successful Chinese women, working in their chosen STEM fields, making the progression successfully from PhD to post-doc or early career stage. This sample would be following their successful pathway of STEM trajectories within Higher Education. Also, as international scholars, it might be hard to choose a life-time career abroad. Thus, I applied stringent selection criteria to invite Chinese women interviewees working in their chosen fields as early career researchers or post-docs, which is at earlier stage of STEM career.

The recruitment of interviewees was similar to that of the focus group: they were collected via a snowball simply strategy beginning with known contacts and expanding to those recommended by friends or by the participants themselves. A time was arranged for each Participant, at their own convenience. In total, four Chinese female post-doctoral researchers participated, working in biomedical engineering, health economics (health science) and biogeochemistry (environmental sciences) sectors. See *Table 9-9.2* below for interviewee information. Although the recruited sample was relatively small, the in-depth interviews yielded rich data, and provided context for the quantitative and focus groups findings, therefore, after completion of the four interviews, it was decided that saturation had been reached for addressing the research questions. For the participants recruitment in the interview, it's ideal5 if they are working for long-period time in the UK in STEM fields. However, it's almost impossible, not because the extent to which these were similar and divergent, particularly in terms of stereotype acquisition, facilitators and barriers to STEM study and future career perceptions. Selection criteria is further addressed below, but participants were highly qualified learners in STEM fields, therefore postgraduates and particularly PhD researchers were ideal for demonstrating successful STEM trajectories within Higher Education.

Table 11-7.1: STEM study subjects of interview participants

	Pseudonym	Field	Working year	Ideal job
China	Anna	Biomedical Engineering	1	Researcher/Academic
China	Emma	Health Economics (Health Science)	2	Health consulting or in health industry (reason: no need for continuous learning)
China	Sophia	Biogeochemistry (Environmental Science)	1	Researcher in non-academic institute (reason: prefer none challenging work)
China	Jennifer	Instrument (Biomedical Engineering)	1	Researcher (in academia)

7.3 Procedure

Upon initial recruitment via adverts, flyers and emails, I contacted several potential interviewees, the consent forms and plain language statements were emailed and a time arranged to meet the participants individually. The interviews were conducted in a small quiet coffee shop, which was a common public place to talk I ensured that the coffee shop had relatively confidential space (open both with block resits eye contact with others) that interviewees were not disturbed by others and keep comfortable social distance to the research. This made sure the interviewees were comfortable to talk and discuss issues with the researcher. They lasted different lengths of time according to the interviewees, from one hour to one and a half hours. I as the principal researcher was the interviewer. I tried to ensure it was a relaxed conversation, so that interviewees could offer more information to help the research. Questions were asked sequentially to help build up a timeline for each interviewee. If there something unexpected emerged or a personal experience relevant to this topic, they were encouraged to elaborate.

7.4 Ethical Considerations for Interview

Ethical approval was granted by the College of Social Sciences Research Ethics Committee after an application was made simultaneously for phase one and phase two (see 7.7 and Appendix 5). Nevertheless, some specific ethical features needed to be addressed in the focus groups and interviews. All of interviews were recorded throughout the whole process. These recordings have been kept safely and only used by the researcher and supervisors for reviewing and analysis. The records will be erased after the study is completed in 2022. In the Interview, all participants will be kept anonymous and none of their names will be mentioned in the transcripts, with a participant number used instead. They were all free to withdraw at any time without giving a reason. Pseudonyms were used to replace their real names, but their study of subject was noted, in order to be able to contextualise them in the findings. Also, it is important in research to ensure that participation is voluntary, and that care and respect are shown towards participants. If they felt uncomfortable about prejudice or stereotyping, during the focus groups and interviews, they might feel distressed when others talk about their experiences. Therefore, they were free to leave at any time, but no distressed occurred and no one left. To protect them in such situations and to extract as much data as possible, as the researcher, I paid close attention to each participant during the procedure and gave out the questions before I met so that all participants would have a sense of what they would face. They were emailed with questions (a debrief sheet) before they arrived. To protect the participants' confidentiality, any information that may lead to their identification was omitted from this research, especially in this phase. The information contained herein does not correspond to the order of answering time and interviews.

7.5 Data Analysis

7.5.1 Interpretive Phenomenological Analysis (IPA) for Interview

The purpose of the interviews was to understand how Chinese women in STEM professional fields are able to pursue their careers. The key elements of this stage were to determine how certain factors affected their career trajectories in STEM and how any personal experiences enhanced their own first-hand experiences, or how they dealt with obstacles to progression. Therefore, I used a different strategy to analyse the data with interpretative phenomenon analyses (IPA) to get a deeper understanding of the stereotyping of Chinese women in STEM and their motivations and influencing factors.

Even if TA can analyse interview data in a deductive way, and it is quite useful for exploring new terrains (Clarke and Braun, 2017), it is not enough to reach a deeper understanding of the personal experiences of facing gender-science stereotypes and sexist attitudes for these Chinese women in professional STEM fields. TA helps define different themes and factors relevant to gender-science stereotypes of women in STEM that emerged in the focus groups, but I could not gain a full understanding of what happened behind their stories in the interviews. When it came to interview analysis, IPA was a better means of achieving the purpose of this stage of the study.

From Smith, Flowers & Larkin (2009, p.1), IPA refers to 'a qualitative research approach committed to the examination of how people make sense of their major life experiences. IPA is phenomenological in that it is concerned with exploring experience in its own terms.' IPA was extensively introduced and used in health psychology to help understand the empirical work of illness experience (Smith, 2011). IPA was selected because the research questions focused on personal experience of how they achieve and persistent in STEM fields. I aim to gather data regarding the experience of being a female researcher in STEM fields and the factors that might affect their careers; I also wished to determine whether they had experienced gender-science stereotyping and what factors might or might not have impacted this. Accordingly, at this stage, the core study would concentrate on the objective of describing and understanding the experiences and on the factors that influenced these experiences.

7.5.2 IPA: the Dual Role of the Researcher

IPA methodology tries to understand the experience of participants from their own perspectives. This requires interpretations from two aspects: the participants' own understanding of their own experience and the researchers' interpretation to understand that. This means IPA is used to reflect the constitution of data and meanings of the data under analysis (Shaw, 2010). So, the researcher is engaged in a double hermeneutic as it is referred to by Smith, Flowers & Larkin (2009): The process of interpretation by the researcher is to try to understand the participants' understanding of their own experience. Researchers, as human beings, share the same mental skills as the participants; at the same time, researchers employ those with high self-conscious disciplinal and symmetrical manners. As a result, the researcher can only access the participants' experience through the participants' aspects. To get the best results, researchers should take steps to make sure they engage with the data and understand as much as possible.

7.5.3 How to Use IPA in the Study

Given the dual role of the researcher in IPA, the researcher must engage with the data. Following the instructions in Smith et al. (2009, pp. 82-107), I read and re-read the data and checked with the audio recording as much as possible. Also, some common processes and certain strategies are employed when using IPA (see details in Smith et al. (2009, pp. 79-80)). In summary, starting with the initial codes to themes, then across patterns with the development of a "dialogue" including the researchers' psychological knowledge, codes, etc., finally, a framework is developed from the different themes.

Overall, the qualitative analysis was conducted by applying the principles of 'data condensation, data display, and conclusion drawing/verification' (Miles et al., 2014, pp. 12-14). Since the condensation process involves sharpening and discarding data, to some extent, the depth and complexity of the data can be lost (Bazeley, 2013; Bryman, 2016). To minimise the concerns of such criticism, analytic memos were carefully recorded while coding so as to record any issues, comments, doubts and interesting points that arose across the entire data set. These memos help the analysis in the sense that they contain important observations and insights for identifying noteworthy details from the transcripts, as well as for capturing the story as a whole from each participant.

In qualitative analysis, the first step is to read your data again and again. After the researcher is familiar with the data, multiple means can be used to understand the data. Given the purposes of this research and the results from the quantitative data, inductive approaches might be efficient for this study. During the data analysis, certain new issues and phenomena emerged. The more familiar you are with the data, the more can be learned to answer the relevant questions, as the data would not appear the same as the first time you saw it. You could develop a deeper and broader understanding of it. In our research, I were trying to identify any role models that might be essential for a STEM career. Immersion in the data involves multiple readings to the point that the investigator can move immediately to various locations in the data to compare and contrast one part of the data with others. The report should describe this immersion.

7.6 The Research and the Researcher in Phase Two

To justify my selection of methodological framework, I argue that my own experience and values may unavoidably have an impact on this research (Bryman, 2016). Also, my identity would have a significant influence on the research, such as my gender, class, race, and background (Ramanathan, 2005). To critically reflect upon the whole research process from raising questions to data collection, data analysis and presentation of findings, it is worth considering how certain factors might have affected me as a researcher in this study. The following subsections will discuss these potential influencing factors.

7.6.1 Gender and Culture (Reflexivity)

Being a female PhD researcher from China makes me ideal for the purpose of this research. As I said at the beginning of the thesis, part of the research was inspired by my own experiences of having studied in the two countries. This has allowed me to understand the research from an involved position in terms of question formation, data collection and data interpretation. For example, with my standpoint, the participants were more devoted to the focus group discussions and the interviewees felt more comfortable expressing their real thoughts. Therefore, my gender and experience enhanced the relationship and bond formed between the researcher and the participants in the qualitative phase.

Despite my privileged position as a researcher in this study, this could also be a limitation. As I already have had my own experiences and pre-conceptions, I sometimes would lead the question or ask questions in a certain way, or perhaps I would over-interpret the answers from the participants in phase two. This point is another example of the researcher's impact on the qualitative research process and analysis. What is more, I have strong beliefs about what I am exploring, I am passionate about solving issues of gender inequality in my home country.

To avoid over-influencing the study, I took great care to be self-disciplined, and invite feedback, in every step of the research. Also, for the interviews, the transcript interpretations were translated and checked by three colleagues. Throughout the interpretation of the data, both of my supervisors paid close attention to each of my steps. Furthermore, consciousness that I might be misled by my strong stand in this research, I checked many times what I was feeling, checking in with supervisors, and iteratively re-coding where necessary until the participants' voicers were heard- which made me more objective and able to see the whole story of this sample of women. However, the goal of these interviews was not objectivity, and not only would such a stance be impossible, but it would also not yield as rich data. Strategic subjectivity of the interviewer is an advantage, my identity as an 'insider' allows me privilege to be closeness to the topics. Also, it's a strength that I'm so similar to women that working in the STEM fields, which makes me more comprehension and deep to the potential answers behind these.

7.6.2 The Impact of Identity

Besides gender, other factors might also have an impact on this research. As an Asian and Chinese woman in this field of psychology the research can be related to my identity of culture differences. The research was focused on STEM women from both countries, so I must pay close attention to this. Similarly, not being a "native" researcher might have influenced the relationship between the researcher and the British participants. In some studies, researchers have found that participants tend to feel more comfortable with researchers from their own ethnic group (e.g., Archer, 2002). The same might have been the case in my research, as the British participants in the focus groups might have been less reflective and more cautious. Considering this situation, I took positive steps to encourage them to talk or answer each other in relation to the questions or themes; this was another advantage of holding focus groups, whereas in the interview to improve the natural flow of discussion. In addition, here I used my mother tongue to interview the Chinese participants. This benefitted the study because the participants could immediately understand the questions and were able to respond using their natural language and instincts, and thus provide a more honest and deep insight into their own experiences. Lastly, as the only researcher in this project, I am unable to thoroughly reflect on the possible impacts of the research. I am aware of the possibilities and have made attempts to ensure the research is as transparent as possible.

7.7 Interview Results and Findings

The findings from the interviews not only further developed the findings from the focus groups but also revealed other issues and explored further the factors affecting women launching their careers in STEM. This provided a deeper understanding of further obastacles facing Chinese women with a STEM career. The *table* below summarised the findings from the interviews. The interview data was analysed using IPA. The results will be presented case by case, as each woman represents their own career journey, rather than presenting theme by theme, but this is followed by drawing out the similarities and differences of those experiences as a cohort. Therefore, what follows is a narrative of each concept that emerged from the individual, and then shared, lived experiences of these four women working successfully as post-docs in their chosen STEM fields. These narratives include exemplar quotes, to really hear the voices of these women's individual experiences. The next section begins with an overview table prior to deconstructing the emerging phenomena for each of the women in this cohort. Although IPA is often presented in a thematic manner, for the purpose of this research the phenomenological experience is more akin to a case study approach for each woman's journey into employment.

As mentioned in the overarching aims, the main purpose of the study was designed to follow a close look at Chinese women's educational and career trajectories in STEM fields, including, influencing factors, stereotyping experiences, key transitions, overcoming obstacles, and how they made crucial decisions about their STEM journeys. To get along all of these narratives, the interviews were essential to narrow down these questions and present a whole pathway which might be missing in in the earlier phases of this PhD. In the previous two studies, what I learned that significant intranational differences of implicit gender-STEM stereotypes only showed in the Chinese group. Also, Chinese women working in STEM might be much more influenced by their family and culture, as emerged in the focus group findings. Therefore, I needed to further explore into this Chinese women's perspectives to understand the experiences of these women when working in STEM fields in the UK.

Table 12-7.2: Interviewee Themes

Participants/ Findings						
Participants 1: Ann	Interests in STEM were found late	parents' impact and expectations of career	Chinese college entrance examination (CCEE) was essential factor in STEM career choice	persistence to conquer difficulties	no special personality characteristic of strength for STEM	work-life balance was hard for Chinese women in STEM
Participant 2: Emma	natural love of maths, STEM applied to real life	parents' expectation changed after doing a PhD	self-confidence built up by conquering difficulties	no gender-science stereotype experiences	curiosity was special characteristic for STEM	work-life balance: could sacrifice for family
Participants 3: Sophia	learning STEM was easy to get a job.	outside activities and played with boys	no female role of STEM fields	stereotype experience of being a female PhD	persistent and rational was special characteristic for STEM.	work-life balance: will definitely sacrifice for family
Participants 4: Jennifer	natural interests to Maths	strongly associated men with STEM, play boys' games	open-minded parents with lower expectations of her	no gender-science stereotype experiences, strongly impressed by being a female PhD	patient and tolerance of loneliness was characteristic for women in STEM	work-life balance: only keep part of work for family different life experience between two countries

The Chinese interviewees were all working in the UK as early career researchers (ECRs), which were good exemplars for successful work at their earlier career stage, because they have already achieved successful careers in STEM fields as independent researchers, and how they successfully transition from their higher education study stages, to echo the original question from this study: Why they retained and not leaked from that "leaky pipeline" at this earlier working stage. Each interviewee will now be discussed in turn before moving to thematic similarities and differences.

7.7.1 Ann: "I have higher expectation on my career"

7.7.1.1 Late interest in STEM

Anna showed an interest very late in STEM: *"Emm...I began to have concepts about science and engineering after I went to university"* (Anna, Post Doctor in STEM, Appendix E, line3). She did not know what exactly STEM was before she went to college, and she became interested in a career when she was a postgraduate student, unlike most of the participants in the focus groups. She tried to repeat these 'late interests' statements many times in her interview (also see line 8), which showed her happiness to finally find what she loves: *"I felt it (pause) seems enjoyable and having fun to do research and technical staffs"* (line 10). Also, her interests driven both by internal and external motivations, *"...Since the first year of basic subjects, such as physics and chemistry, I have a primary concept about what I gonna do."* (line 5), to be more specific, what she really liked about her work was the practical aspects; she could gain a sense of achievement when she obtained the results directly after some hard work: *"Yes! ...I conduct one model, then I have results which are very visual to see how it works. if it works well, ...I feel a sense of achievement"* (line 12-15).

Even a job offer seems easier to get when qualified with a master's degree in STEM fields (see line 19-23), Ann has sceptical opinion for job choices *"...I would like to find a technical job instead of a sales job...the longer I am practising in this field the more interests I find"* (line 25), which these job choices could make her happier rather than obey the social rules: *"...No* *matter where I am doing this, these techniques could apply to patients directly, they will be better. This makes me feel satisfaction!"* (line 28-31). She was quite excited when she told her feelings about jobs and found she was genuinely interested in the practical side of her work and in helping people. These interests in STEM grew the more she practised. She felt satisfaction when doing her job well and helping people, even if she felt hers were not supposed to be the best and traditional choices for her in these fields.

7.7.1.2 Parents' impact and expectations

Anna's parents set no barriers for her study and encouraged and supported her to study whatever she wished to learn: *"Actually, my parents are both accountants, didn't learn much about science and engineering, I don't think they had an impact on my academics. In terms of study, they gave me as much freedom as I could have, so that I could choose what I would like to learn, and they would offer me their best support for me."* (line 35-38), she felt security about her parents' supports and quite positive about what she decided to do with these supports: *"they (parents) have expectations for me: if you want to do something, get devoted into it; try harder and do well! ... Don't ever be negative to do things!"* (line 54-56). This put less pressure on her and allowed her to develop an open mind. Most importantly, she was independent, decisive and determined to try harder and do well. Her parents had lower expectations of her career than she had herself, perhaps she felt because she is a girl. P1 repeatedly explained how she managed to choose her career by herself, how she had made it up to this point and what she would achieve in her career. She might have liked to have had more support from her parents.

However, when she talked about her career expectations, she felt disappointed about her parents' lower expectations for her: *"…They don't expect too much from me, no need for high achievement, for instance, a lecturer in the university would be fine. As long as I go back to China and live not far away from them. Actually, they have lower expectations about my career, It is me, at this stage, I am concerned more about the level I could achieve in academia"* (line 58-63), Ann was disappointed and meant every word that she had a higher expectation of her career, because she could achieve even if her parents would not expect this from her.

7.7.1.3 Chinese college entrance examination

Anna chose her major subjects of study before entering college, with less knowledge of what STEM in college was actually like. She states that it was "fate" that got her into her major. The import event was the Chinese college entrance examination*: "one of my cousins was studying engineering, I thought that was cool! I took engineer as my second choice of majors in university, I am quite fond of drawing, I put architecture in the first major on the list. ...I failed the first one, so that I end up with engineering. Actually, I didn't know anything about the majors before I went to university. Sometimes, I made choices by 'this might be fun' or things like that .... Unless now, I wasn't giving enough information about these at that time. I only select one by relative a few information about that major"* (line 39-50).

7.7.1.4 Persistence is the key to conquer the difficulties, no special characteristics found as a woman in STEM fields

Anna did not find it easy-going when she set out at the beginning of her research work. She was confused but tried to find solutions through persistence. She said: *"I met the first obstacle was the language, which was common to Chinese international students. Then I found confuse when I started my research, in UK, supervisor gives you more freedom and authority to your own research. I was doubting about my research "am I suitable for research?"* (line 66-68). Also, she did not think there are any special characteristics of women in STEM, as every woman could do this: *"... you have to meet some difficulty when you are devoted into research. But you need to study persistently and suddenly you'll get it, solution found...you are doing what others not doing before, ... that's a process you have to go through"* (line 73-76). She always showed strong confidence on her career even it's hard, which came from her parents' supports and her career ambitions. Even she said: *"I don't think there is special characters for women to study in STEM, every woman could study STEM...maybe for nowadays, women are more rational? And more practical to get used to engineering work?"* (line 104-108), the persistence and confidence found in herself was quite special, and helped her achieve her career goals in STEM fields.

7.7.1.5 No overt experience of gender-science stereotypes

From Anna's comments, she felt she had never encountered any negative gender-science stereotyping: *"It's not likely I met negative or malicious stereotype in life before...I might block that kind of information on purpose. The main reason because my friends are all PhD women in STEM...but my friends in China would question myself why I need a such higher education and take so long time to purse, what's this for...they (some of the new students just came) are impressive by my major(engineer), they think I am awesome!"* (line 83-87). In fact, she had felt she received 'positive stereotyping' of women in STEM. However, the fact that Ann constantly stated that she had never had any gender-science stereotype experiences might suggest the possibility that she herself might have held this stereotype implicitly. This was confirmed by her statement about gender-science stereotyping in China, which leads to another issue among Chinese STEM women and Chinese women with higher education (as will be discussed in the coming section). She might have avoided this stereotyping intentionally because of her own self-cognitions.

Also, she found British people held some specific stereotypes of the Chinese: such as that they tended to work hard with good temper*: "(thinking for a while) ...I have a feeling that, they (supervisors in UK) think Chinese girls tend to have a good temper and relatively hardworking...to be honest, I haven't encountered any stereotype to women in STEM. At least, I haven't in UK. On the contrary people try to avoid these in UK"* (line 80-82). She felt that in the UK, people tended to avoid showing any type of gender-stereotyping, and encourage women in STEM with supportive communities, which again shows a potential contrast with stating she face no gender-stereotypes in her early educational experiences.

7.7.1.6 Work-life balance: social pressure and expectations of Chinese women

Anna noted that, unlike in China, in the UK, she found that men and women share the same responsibilities in the family: *"in UK... "encouraging" no matter which university they are* *highly encouraging female engineers, even becomes a standard criterion for variation of the school. But in China, this could be a disadvantage for being a woman in STEM"* (line 90-93). She might have been concerned by this as a Chinese woman: *"…But in China, this could be a disadvantage for being a woman in STEM. For instance, (if you ask a position in university in China), they will consider that if you are married or not, if you have a child or not... as you are at that age after a PhD...how much effort you could put into research. This is discrimination to women in China...it seems that these stereotypes (about women) are less in UK"* (line 95-99). Anna was aware of the stereotypes and expectations of women in China, especially women with PhD degrees, at an age to get married or have a child in China. Thus again, the notion of stereotypes is not explicitly acknowledged but the judgements and behaviours associated with gender-role consistency are acknowledged by Anna.

Most of the family work- balance issues are perceived as similar in the two country contexts: *"Actually, this issue happens both in UK and China. Women have to sacrifice part of their working time because of family and children...but it's a little different here, men share the same responsibility after they have a family. And it has gender difference..."* (line 111-114); however, she found different working conditions in the UK: *"... But I quite like "work flexibility" here, you could arrange your work as long as you could complete no matter where you work...in China, it seems no possibility"* (line 117-118). It seems to Anna that women have equal rights and better working conditions in the UK compared to China. This enchoes the same issue the focus groups discussed of the similarity of female status in the two nations: *"but female PhD pay much attention and effort (compared with male PhD) after having a family. And there's no differences at this point no matter where you come from and what your majors are"* (line 115-116).

7.7.1.7 Suggestions for girls who would like to study STEM

Working in STEM was perceived as needing insistence and perseverance, something Chinese women she felt were particularly good at. *"First of all, set a stage for STEM, during this process, you will learn if you like it or not...further, learn to enjoy loneliness...STEM sometimes* *is monotonous and dry...you need insist and perseverance"* (line 121-124). Anna's suggestions gave credit to her interests and persistence to them, as well as a type of resilience she felt she possessed at the individual level.

7.7.1.8 Summary of Anna

Anna started showing an interest in STEM she felt very late. She seemed to be confused as to why she had chosen this field in the first place. She did not give reasons why she liked it once she had started down the STEM path in education, but later on, she found a sense of achievement from the projects she carried out during her master's degree. The initial point at which she chose her career was when considering the Chinese college entrance examination. She viewed it as "fate" that she had gone into engineering instead of architecture. She considered herself to be lucky that she eventually liked it and found that it interested her. She noted a lack of information to help decide what major to study at university. She started to show a real interest in STEM as a result of her master's experience. That was when she found her true motivation was to help people. Accordingly, she received great satisfaction from what she did.

Her parents, she felt, had lower expectations than she did of her career. She aspired to achieve at a high level in her field. She showed strength and resilience when making decisions about her career. She showed a strong attitude in every decision she made and stated 'this was my decision or 'my parents don't affect my decisions' repeatedly. Although this self-reliance might show that she lacked role models or true support during her career, and perhaps this was showing in less confidence in her future career onward from this early career stage. At the same time, she was devoted to her career and would like to pursue it to the highest possible level, despite increasing social pressures.

Overall, Anna seemed disappointed by her parents' attitude towards her, feeling that she deserved much higher expectations not only from her parents, but also from society. Anna had hidden ambitions for her career. She was partially aware of the impact of the diverse stereotypes of Chinese women, especially of women with high education backgrounds and she strived to rid herself of the negative impacts of this condition, but conversely explicitly denied facing gender-stereotypes in her earlier educational experiences. Anna felt women seemed to have slightly better working conditions in the UK, and equal family responsibilities as men, when women trying to balance family and work.

Anna stated that she had not encountered any experiences of stereotyping. of women in STEM. In her attempts to explain this, she might have indicated that she knew this stereotype exists and that she might have been experiencing it implicitly. She did not deny that women like her would suffer from a lack of equality in terms of access to university employment. Simply because of the fact that she could be a wife or a mother, she was vulnerable in the workplace. Her ambitions for her career had been strengthened by the fact that she had got so far and wanted to achieve something. Noting special characteristics of women in STEM, Anna stated that the reasons why women could be qualified (for engineering) now is that women had become more rational and practical. Women need to have a strong mind to enter STEM and show great perseverance.

7.7.2 Emma: "I'm just good at Maths"

7.7.2.1 Natural love of maths, STEM applied to real life

Emma showed her favour of maths in primary school: *"primary school, I never show love to Humanities...mathematics always is easy for me...I found Chinese was hard for me, I hated writing...no special reasons why I am interested in Math...this is quite nature"* (Emma, Post Doctor in STEM, Appendix F, line 2-6). What's more, her interests were supported by her parents*: "Parents respected my choices (to STEM), they know I don't like Humanities, something that needs to remember..."* (line 7-9). Her parents respected her interests. She loved to play with cars rather than with dolls*: "I didn't like playing dolls and cars. I like watching TV... and playing Chinese chess and pokers..."* (line 14-15). Also, she was fond of logic games when she was little. She chose her major because she later found that maths could be applied to real life to deal with data, which she found motivating: *"...I like the field of health economic because no need for experiments, I am not practical at all...I prefer play with data, more statistics and maths. Actually, the reason why I chose this because it applies to real life and no experiments. This could give me more motivation to do, it's meaningless if it's far from real life"* (line 33-46). Emma started to know her interests of math at very earlier age. With supported parents, she developed other related skilled and made sure of her real interests in real life. When she started to talk her interests developed, it seems like she had a self-story to make sense of every detail of odds and differences with others (compared with girls' toys). She gave these details quickly, even without asking, like she has spoken of this often, and had persuaded herself or others so many times of this narrative. Those concepts she touched upon included 'natural interests of math', enjoying 'boys' toys' and logic games, and other concepts that perfectly fit into the other side of women's counter-stereotypes, which suggests Emma was aware of gender-STEM stereotypes, and that she used them as sense-making for herself and others, particularly when trying to protect and justify her interests and avoided misunderstandings from those around her expecting more gender role-consistent expectations.

7.7.2.2 Role model when little

Both parents had an implicitly positive impact on her serious attitude to work and her rational way of thinking. *"I was dreaming of being a journalist because my father was...but my father would not agree with that...my mother is a doctor...she has an impact on me doing work seriously...my father was in physics in college, he has an impact on my rational thoughts...also, he would explain physical phenomena in life..."* (line 20-27). Given more evidence on why Emma chooses STEM, it might be parents were both in these fields that encourage and support her to pursue in STEM areas.

7.7.2.3 Parents 'expectations before and after PhD in STEM

Continued with parents' impact on Emma, it showed different attitudes before and after she had obtained her PhD. Before: *"It... seems based on my own decisions. My parents show less control of it...my father suggested me to choose medical test (major) instead of economic (my* *choice) in university, (so I chose that major) ...but it's okay I am back to this field (I love) ...my parents never interfere too much on me"* (line 42-46). The impact on Emma did not show directly. In fact, it appears she followed her parents' expectations for her major, with her initial choice of subject to study at university, before changing to study what she really liked. When she tried to recall and state these words, Emma slowed down her speed and turned into confused tones to speak out. Then she said: *"In China, my family would say being a STEM PhD is quite okay with them...",* I found she had something not to say, I asked: *"is that your family more concerned about your PhD than what majors you study?"* Emma immediately gave respond with former speed: *"Yes! Yes! Exactly! Because my parents both have STEM background, it doesn't matter...for example, I have a friend, she's very good at Humanities, especially writing, we all thought that she would study Humanities majors but she chose science and engineering because her parents convinced her that this might have more job opportunities...I always have a pity of burying up her talents of arts...but I am not, I am taking my advantages now(laugh)."* (line 111-117). Emma told this story to express she felt lucky that she likes the subjects that her parents would like her to do, and for her friend it was not the case. Otherwise, she feels she might have ended up like her friend too.

Emma's parents were described as very much more concerned about the fact that she had a PhD degree, rather than she fact that she had chosen a STEM subject. She was sad about her friends and hope that her friends would use her talents for work. She was aware that her parents had an enormous impact on her career choice. However, she felt she followed her own interests in her choice of career. She was also worried about her parents' attitudes towards her PhD degree. In the formal interview, she tried to explain that it was 'only a job'. The emotional speed of her speech, the example she gave, and the fact that Emma seemed to centre herself on having interests in mathled me to question: did Emma likes math, or did she like the story and conception of her being a 'girl who likes maths' and the social and parental favour that followed. Considering the 'story' she seemed to repeatedly tell others, Emma might also be persuading herself (making sense to self and others) to meet and exceedher parents' expectations at the same time as following her own interests.

7.7.2.4 Difficulties to overcome to build up self-confidence

At first, Emma expressed that she was frustrated by the language difficulties and having to adapt to a new study style: *"I met chemistry in university...I changed another major after studying aboard...language (English) was the first obstacle...I didn't catch up in the class...I began to understand that I need to get used to this learning style (study aboard)"* (line 49-62). This she felt was quite common among international students, and this also emerged with other Chinese interviewees. By trying hard and managing to complete her PhD, she felt she regained her self-confidence and was better able to face challenges: *"I felt confidence after finishing PhD and the more you learn, the more you need to learn...one of my supervisors think that I am a good learner, expecting me to transfer into a new area.... the more you are capable of, the more challenges you have...so I felt not that confident again...too much uncertainty...I might try because the job promising...I am sick of academia now, I would like to do something relevant to my area... there is not much motivation for me in academia."* (line 67-82). This statement indicates a growing trend of women leaving academia early in their career for industry careers and opportunities, even if they are outside STEM and outside their original area of training.

7.7.2.5 No gender-science stereotype barriers

Emma felt she had not explicitly encountered experiences of gender-STEM stereotypes, as she stated, the reasons might be all of her friends were from her field: *"it seems that I haven't encountered any...all my friends here in UK, they are all PhD and know each other well...I never feel harm by anyone because I rarely have new friends...specially I was in a science class in high school, a lot of girls were in that class...for other people not in this field I rarely met anyone or anyone not a PhD…"* (line 85-88). Another reason might be the environment she was in. She seemed quite comfortable with the stereotype-free experience of the applied sciences environment, where plenty of women work: *"…for PhD, I think this is only a job...for women in STEM, I don't think what I am doing is hard science or core science, it's more applied science(health). So, many women in this field and so as the doctors...my whole research institutions almost are women...I think women study STEM is quite normal, so the discrimination might be rare"* (line 86-97). Furthermore, as it takes time and effort to make new friends, she was in a position only to meet people from her field. Perhaps, she was simply not good at forming a social network with people not from her fields.

One cultural difference she noted was the fact that British people tend not to express themselves in front of other people. This might be the other reason she had not encountered any stereotypes in UK*: "I felt UK is relatively better. I have met a lot of British people here, but I felt nothing about (the stereotype). Even though British have different opinions to different occupations, but they won't show on their languages"* (line 88-89).

7.7.2.6 Personality characteristics of strength for STEM: curiosity

Emma always kept a fresh and curious attitude to her work: *"Curiosity and enquiring mind...I've got an algorithm from one of my colleges, I found a way to simplify the algorithm...and I did it, very interesting and efficient...maybe Chinese could do better on algorithm..."* (line 85-97). You could tell when Emma truly like things, here she spoke faster with no stop, showing a genuine internally motivated passion for algorithms.

7.7.2.7 Work-life balance

Emma felt that having a family would mean sacrificing her career goals: "*I can't take as a housewife and not work at all, and I need to keep my work sustain. If I stop for a while, I am afraid it's hard to continue that's bad to my career..."* (line 120-122). Again, she might know what female role in family and society, which fits into the gender-STEM stereotypes that she needs to persuade herself and others. As she was determined to have her own career, she insisted that she would not give up her work because of a family. But, she then conceded that she could sacrifice a little, perhaps by taking a part-time job *"...I will take efforts to keep balance. For example, part-time job...but it's hard to be true in China, I am not sure (my future) ...I still could stay here at least… But I am having child right now, my parents don't give me that pressure, they are open-minded. I made my own decisions"* (line 125-129). These comments appear to indicate that she felt the ideal work-life balance was not possible, even in the UK. She gave the example of a colleague, which seemed an effort to comfort herself who was smuggling with her life and work. Nevertheless, in the UK the working conditions did appear to suit her better.

7.7.2.8 Suggestions for girls who are interested in STEM

Emma was enthusiastic about STEM, and really believed that women could succeed in this field. But it seemed that she was not sure that girls would really show an interest in STEM. Her feelings might have been influenced by her friends, and she might have been in the minority when she was little as one of the few girls interested in maths*: "they have to learn what they are interested in... if they really like STEM, please do be into it (enhance tone)! Because this area is wide. In realistic, it makes you have more choices than Humanities..."* (line 147-148). here Emma seems that continue to persuade herself with perhaps from her parents' words, however, interest is the key to keep her going on. But she says that she would be thrilled that if girls really do love STEM by giving realistic advantage reason: STEM subjects were easy to get jobs in China*: "…one of my girlfriends learning electricity in China, only few girls in that class, they had a (pretty good) life! (laugh) but girls still are few in STEM (in China)! over here (in UK), people encourage and support women in this field, that makes women in STEM have some advantages, for example, some jobs need gender balance..."* (line 149-151).

Furthermore, Emma felt that even in male-dominated environments in the UK, it only offered women more chances to take advantage of the opportunities in these fields because of the lack of women working here in the UK*: "...of course if a working condition is full of men, a woman comes in, the efficiency would improve! ...I felt women have privilege in jobs than men if the same conditions in UK because the policy of gender equality, the percentage of gender equality is essential..."* (line 152). Policies, Emma felt, privileged women working in STEM jobs compared with men with the same qualifications. She seemed quite optimistic regarding women working in STEM and did not feel that they suffered really from any disadvantages. She had worked in the UK for a while and had developed real feelings on these issues. Her future career, she felt, appeared to be promising, and the barriers she perceived were not structural or institutional, but rather concerned work-life balance in future, as well as opportunities being greater outside academia.

7.7.2.9 Summary of Emma

Emma expressed a ‘natural’ love of maths when she was little. She also might have further developed a sense of privileged value on logical and ‘rational’ ways of thinking, prioritising games that required logic, such as playing chess and poker games. Further, her parents might have had an impact on her value on maths and rational thinking, as they had both studied STEM subjects, and placed a great weight on these for future career success. These factors might all be related to her interest in maths. She really loved maths-related work and was particularly motivated to apply it to real life. Even though her parents showed respect for her choice initially, they seemed to interfere in her choice of subject of study when she went to university. Her parents’ attitude changed rapidly after she began her PhD. They worried that her high educational background would cause trouble for her in the future in terms of different social aspects, including getting and maintaining her own family.

When studying abroad, she met with the common language problem. When she transferred to a new subject of study, she had to get used to that new language too. Emma expressed that she had not had any direct experience of gender-science stereotyping, and she felt this was because she was in an area of applied science that was not male-dominated. But, even in a male-dominated subject, she felt this would only afford her more opportunities, and potentially ‘positive discrimination’ could mean she would be hired over a male colleague. Furthermore, as she had few new friends, which she felt limited her experience of such stereotypes. In the UK, she felt that even when people hold such stereotypes, that they would not express their attitudes explicitly.

Emma was unsure about what future research direction she would take and was growing tired of academia. Emma has an enquiring and curious mind. She has a rather pleasant character, tending to view everything around her in a positive way. Her parents doubted her PhD career, although she seemed not to talk too much about this, perhaps because of her optimistic and acritical character. She repeatedly emphasised how open-minded her parents are. Moreover, Emma appears to have great self- confidence, and no evidence of so-called imposter phenomena. She felt pity for her friend who could not study the subject or follow the career that she loved. She is cheerful about herself and can see plenty of advantages for her in her career. Furthermore, when describing the career conditions for women in the UK, she feels that women have privileges in the job market because of policies to ensure gender balance.

7.7.3 Sophia: "I am a Tomboy"

7.7.3.1 'It was easy to find a job'

Sophia had to make a choice when she did not wish to study humanities in high school. When it came to choosing majors in university, she chose majors that would make it easy for her to find a job. After that she was pushed to choose relevant STEM subjects until she 'ended up' doing a PhD.

Sophia started the conversation with a practical consideration of 'job' rather than other's 'love' or 'interests' for STEM fields/subjects: *"I studies environment science when I was undergraduate, including biology, chemistry and etc...actually this was not my first choice of majors, the first two were finance, the third was English, because I like, this the fourth choice, because that's popular in China to find a job..."* (Sophia, Post Doctor in STEM, Appendix G, line 11-14). However, she gave the reasons for the starting point of this struggles of majors: *"high school...I found myself doing relatively better on STEM than Humanities subjects in high school...I had to choose between two…"* (line 3-7), which she explained immediately and she was very proud of she wasgood at some things in the STEM fields: *"I was not that bad at*

Humanities, I hated to remember...I was quite good at physics...>120/150 on Maths." (line 7-8).

It wasn't until very late in her educational journey that she found what she's interested in: *"...but I really didn't know because no one told us what these majors could do... everything became clear to me after I got into the university...I never choose what to learn, it just went naturally...for instance, I was chosen to study specific majors when I was postgraduate ..."* (line 15-21). Still, she had no clear idea why she chose her subject of study: *"... I had no alternatives for me...I had to choose the relevant subjects when get into PhD..."* (line 21-23). Sophia asked herself why she chose this path, observing many reasons form the outside (external motivations), she felt she tried to make this decision to fit the environment and make sense to herself. She seemed confused and uncertain much of the time because she did not know where her educational journey would lead to, or if she could ask someone to help when she made the decisions (lack of role models discussed below).

7.7.3.2 Playing with boys when young

Sophia enhanced her feelings of having a 'different' image than other girls with: *"I was quite fond of outdoor activities, so I am playing with boys, rather than playing with girls or girls' toy, for instance, dolls"* (line 33-35). She tried to distinguish and compared with other girls with many ways. she comminated herself 'different' with pride.

7.7.3.3 Lack of female role models in STEM fields

Still, Sophia observed no role models for her career: *"Actually, I don't have any role model (in STEM), my dream was to become an English teacher when I was young..."* (line 27-29). Instead, she only had English teacher role models when she was young: *"... I didn't have any role model for my career now, but I did have English teacher (female) as my role model back then"* (line 29-30). Again, she chose her major not out of any great interest, but simply after weighing up the relative advantages and disadvantages for her future after the Chinese college entrance examination*: "...And choosing this major was not I want or not, it was a decision with complicated and throughout considerations after the (Chinese college entrance) examination"* (line 31-32). As she really liked learning English, that became the foundation for her subsequent study.

7.7.3.4 Typical Chinese parents with high expectations

Apparently, Sophia's parents had relatively high expectations of her and offered her as many opportunities as they could: *"My parents are typical Chinese parents, what they only want from you is to study hard and they tend to let me into STEM fields because that's easy to get a job...my mother is a Chinese teacher and my father works for the government. They were not having a particular Humanities or STEM background...they are practical...my mother asked me to do many things to improve myself, such as singing competition, hosting, broadcasting and Ping-Pong, etc...mainly based on my characters and what opportunities I have during the school...I tried many many things when I was young..."* (line 38-48). Again, Sophia tried to explain how different she was with these expectations, she gave herself an identity labelled as 'fake boy' (Tom Boy in English content*): "...but I was quite like a boy, playing with boys until high school... like "fake boy" inside?"* (line 49). She stated that she was a 'fake boy' as she did not play 'girls' games and like 'girls' activities. If she had formed an implicit association between men and STEM, this might have constituted an inner motivation related to her self-identify- with a gender-inconsistent identity at some level- in order to avoid stereotype-consistent personal traits and role behaviours.

7.7.3.5 Stereotypical experience of being a female PhD

As with the other interviewees, Sophia expressed no overt experiences of confronting stereotypes as a woman studying or working in in, however, she did related experiences of being a Chinese female PhD and post-doc in the UK *"I haven't encountered any stereotype experience about women in STEM, but mainly about female PhD and female Post-doc...in UK, people would be surprised when they learnt what I am studying, that might because Chinese* *students all come to study business and finance...I have been in STEM so long, I have not special feelings about women in STEM, but some of them are really impressive"* (line 70-78).

She appears to hold her own stereotypes of women in STEM fields- from appearance to traits, she felt women from different areas of study have different ways of dressing: *"once two groups of my colleague were out for dinner...people from UK (male) said that the outfit for women in physical geography were outdoor style but the women in geography look like more dress up (office lady), taking care of their appearance...this might be relevant to different majors"* (line 82-87); but she felt women in STEM tended not to take too much care about what they put on, although she did not to say that they do not dress smartly. Sophia expressed the stereotype of women in the humanities dressing and acting a certain way, and this might be one reason why she felt women are not so present in the STEM field : *"I have stereotype for women in Humanities, they seem to sit down in a cosy place and writing...not that tough (because they need to go outdoor investigating) like us, but they still have the same difficulties when doing research, I mean they could have alternatives for working places, but we have to settle for that."* (line 95-98). Because some STEM subjects involved outdoor or even manual labour, she felt some women may shy away from these disciplines.

7.7.3.6 Special characteristics of women in STEM

Sophia thought that two characteristics of STEM women were important which are their persistence and rationality: *"...you need to be more rational before doing something. Some are subject-specific, you have to make a scientific plan...you need to have a clear mind...sometimes only repeating..."* (line 90-95).

7.7.3.7 Work-life balance

When it comes to making sacrifices to have a family, Sophia did not hesitate, stating that she would certainly do that for her family and children: *"I thought this question before, but I have no answer for that(laugh)...it's hard to answer, it's relevant to "sacrifice": man or woman* *would let his or her career down, focusing more about family. I think women are relatively easier to compromise ... I would do the same when the time comes..."* (line 108-112). Sophia even gave an example of other females which making such sacrifices for motherhood to support these sacrifices*: "First of all, most of women around me did the same thing, they compromised...women have /need longer break when they are pregnancy. They have this chance to (give up career for a while) do this. being a mother, it's definitely more efforts..."* (line 112-114). She might indicate that the society and people around her had a major impact on her views about her family "sacrifice". then, she began to do compromise for her future family*: "It's hard to tell...depends on how much you give up. If I need to give up all of my career because of family and, children, I can't take that. If only certain stages need more time spending on family, then I could go back to work, that's fine. I don't have a strong career achievement goal...but anyway I need a job of my own!"* (line 115-117). She struggled with the idea that she should at least have a job, but she did not have great ambitions for an advanced career, this indicated how family traditional roles affected her cognition. She also seemed to express lower self-esteem when discussing who would sacrifice more for the family.

7.7.3.8 Suggestions for girls interested in STEM

Sophia used an emphatic tone to advise girls to *"find some of the joy and interest in STEM, so that you can keep going on".* This might suggest that she was struggling with her work in STEM or that she was not so interested in her work, which she may have viewed as an obligation.: *"Emm...it's hard to (give suggestions) ...one thing is that you have to be very clear that you are doing what you like...not 100%, but you could have sense of achievement and interests because most of the STEM subjects are quite boring, if you don't have that motivation, it's hard to keep going...you have to have something exciting to yourself, ...even only a part of it."* (line 123-126).

7.7.3.9 Summary of Sophia

Sophia's interest in STEM emerged from the choices she had to make when in high school to succeed in the Chinese college entrance examination. Firstly, she had to pick between humanities and STEM, at a time when she performed relatively better at STEM. Later on, she had to choose a major to study after getting into university. Although these interests were led by her, and felt as if 'natural', both parents clearly had backgrounds and interest in STEM. The message was clear- if you study STEM, you can basically choose from all majors in university including conversion and subject-specific courses; whereas, if you study humanities, you can only choose from humanities courses. At this point, when it came time to choose a major, Sophia prioritised the ranking of the university over the choice of major. She was accepted by her fourth choice, which involved studying a STEM subject. She felt she had no preconceptions regarding any of these choices, except that she liked English. The key point for her was to choose a subject of study, and a university that would allow her to find the best job possible (in terms of salary and status), showing strong external motivations.

It is hard to say how much 'love' or passion Sophia had for a STEM career. She only pursued a career in this area because she had to. It was based on a series of rational decisions stemming from the options available to her at different points. The main reason for her perceived lack of love for STEM might be: 1) having had little knowledge of university subjects of study. 2) having the decision led by the demands of the job market. 3) financial worries, such as about the cost of changing major subjects, although still chose the one she preferred. 4) and finally, not given up looking for something she loved.

Sophia found an interest in STEM (research) very late, in her PhD and Post-doc time, because she enjoyed the process conducting research all on her own. Innovation might be the aspect that interested her most. In allof her educational experiences in China, including her postgraduate degree, there appeared to be a lack of room for independent innovation; she was always taught 'what to do'. This might be a reason why she did not find STEM interesting at first.

While Sophia might have become interested in her work, it is more likely that she was felt forced to do it and that life had left her with no choice. She had perhaps lost the chance to find her real passion, a phenomenon which seems much more common in single-child Chinese families, as the child is raised beneath the pressure of the high expectations from the whole family. Sophia exemplifies how many girls are told to do the things that they are supposed to do and which will “be good for their lives”. Therefore, girls like Sophia may have few chances to learn or to choose their own subjects based on passionate interest. As a result, lives could come to be shaped by these choices, which they rely on more and more on external decision-makers. Many women, like Sophia, feel they cannot afford to risk quitting and choosing another subject. So, they end up living with their choices and perhaps continuing to work in STEM, and academic STEM, without a lack of passion- this is not considered in the ‘Leaky Pipeline’ analogy, interest alone is not enough to maintain, nor lead to an exist, from STEM career trajectories. In fact, the higher the level of education these women have obtained, and the more risks they have taken, the greater the barriers to leaving. This may be particularly true if women have not followed their passions when choosing initial subjects of study they were passionate about. This can become more problematic when they have to continue with it because of the demands of life. When women choose majors that do not interest them, they simply adjust to this situation, and eventually come to enjoy some aspect of it. But a shadow of self-doubt and a certain unwillingness appears to be always there.

In addition to the risks involved in quitting, most single children take this route to meet the expectations of parents or society. Having single children and being affected by traditional Chinese culture, almost every Chinese family has high expectations of their children, particularly of their educational achievements. They view a good degree as a promise of a good job and a good life in the future. At the same time, this brings glory for the whole family. The conflict happens when this only child in the family is a girl. Women have a less important role in the family and in society in traditional Chinese culture. Parents usually will not cultivate girls as seriously as they cultivate boys. Accordingly, Sophia said, ‘If girls have a high education background, they find it hard to get married.’ In China, women traditionally have to be married, which makes them ready to settle down. Parents have to find a balance between girls “surviving” and “marrying”. This leads to the issue that most Chinese parents do not support their daughters pursuing a PhD degree, as they feel it makes it hard for them to become “fit for marriage” in Chinese society. Indeed, female PhDs represent the most unwanted group of women in the potential “marriage market” in China[16].

7.7.4 Jennifer: “Humanities are for girls”

7.7.4.1 Interest of maths from young

Jennifer found she was good at maths and enjoyed science classes. She developed her interest in maths at primary school: *“It’s natural to choose from Humanities and Science in high school. I don’t like geography, but I prefer maths (140/150)”* (Jennifer, Post Doctor in STEM, Appendix H, line 6-7).

7.7.4.2 “I like playing ‘boys’ games, I like STEM”

Jennifer explained that her choice of STEM as career stemmed from the games she loved when she was young: *“I preferred boys’ games and toys when I was young...I might think automatically that men chose science subjects, I have boys’ characters, so I would choose science.”* (line 8-9). She liked ‘boys’ games and toys and formed implicit and explicit associations between men and STEM. She said she has a boys’ character. She claimed that she did not study ’girls subjects’ or that she did not find them very challenging. She was determined to do what she liked and wanted. In fact, she did liked history, but she gave up humanities

[16] In China, if you apply to continue to study after your undergraduate studies, you have to pass a standard examination: “a post-graduate entrance examination”. It has two common areas: English and politics. The subject- specific examination might vary according to discipline or university. Here, Sophia did not take this examination, as she had had this chance before she graduated from her undergraduate university. This chance is only offered to the top students among the undergraduates. The numbers may vary between colleges and universities, but they are low.

because she hated geography*: "I was interested in biology, but I changed into biology, cuz it's easy to get a job...I changed back to my original interest, biology when I did PhD"* (line 25-29). She refused to show a 'weak' (girls' subjects are easy) image of herself to the others. This was the rationale she provided for being in the STEM field and was her own explanation for herself. furthermore, she gave details of how math attracted her at the first time: *"the reason why I like maths, because I was fond of doing maths exercises when I was in primary school, the exercises were not the traditional maths for students, it's divergent thinking...I found them interesting"* (line 21-23). also, Jenifer talked about she refused to Humanities with bad communications skills*: "I have another reason why I chose STEM; I am not good at talking with people, I think no special need for that if I work in STEM"* (line 33). These perceptions are all very typical stereotypic of gender-STEM associations, what matters for women status, even prioritising the value of playing male game, and looking down on Humanities (subjects), even preferring talking with people interested in math major.

7.7.4.3 Parents' expectations

Jennifer's parents tried to persuade her to study economics and law, which were common subjects of study for girls' in China. As mentioned in the last section, she said she thought that these subjects were 'girls majors' as they were 'easy and girlish': *"My parents persuaded me to study economic and law, I wasn't approved, I thought that was too much girls' subjects. even I find these subjects are all fine, back to the (Chinese college entrance) exam, I would still study engineering, no law and economic, they were easy to study...I found engineering quite challenging."* (line 11-17). Instead, she stated she wanted to study more 'challenging majors'. Jennifer was appeared to want a 'challenge' rather than studying 'women's majors', which were perceived as easier. This 'challenging spirit' is quite similar with Sophia, but rather than indicating a purely internal personality trait, it shows gender-consistent stereotype adherence, that 'masculine' subjects are harder and 'feminine' subjects are easier and less valuable. Both of Jennifer and Sophie seemed to think they would achieve more by being different from or separate than other women, that is being like men.

Compared with her peers, Jennifer felt she was given free rein by her parents, while she was growing up, which made her independent in her decision making and not affected by her parents*: “My father was not that tough on me when I was young, he always took me to travel. I was like ‘free range’ growing up. Compared with other peers at that time, they have to finish their homework at time (by parents), but I could play freely”* (line 39-41). Jenifer appears to be more open- minded than her peers. Her parents were not so hard or strict with her. *“My parents’ expectations for me was to have some education, getting into some universities, happiness is essential...”* (line 44). She tried to explain that how less influence her parents on her with no pressure on her career decision. Nevertheless, she seemed quite determined to study hard (in a challenging way) and had high career expectations for herself. Even though her parents respected her, they were still affected by the social expectations for women, which lead to lower expectations from her parents.

7.7.4.4 Researcher in academia

Jennifer developed her interests of being a researcher. As she hates networking with people, she said*: “I am willing to be a researcher in the future. As in China, if you would like to not be a researcher, that will end up in companies, I hate the complicated networking with people, I am not good at it.”* (line 15-16). Thus, being an academic researcher as a career choice was perceived as an escape from networking with people.

7.7.4.5 Role model

Again, Jennifer did not find inspiring role models in her field like others. She liked history (Humanities) and had role model here, but no special STEM role mode: *“no special people. Actually, I was quite fond of history, if I haven’t chosen STEM because I was not good at geography, I would choose Art subjects when education separation in high school...my Mum is an accountant”* (line 35-38). Jennifer chose her STEM field and to be a researcher as a better choice combination for her while she persuaded herself with practical reasons to chose from STEM fields rather than Humanities, although there was clearly a socially value-laden stereotype biasing her against studying humanities subjects she enjoyed (like history).

7.7.4.6 No gender-science stereotype experiences and being a female PhD

In the UK, Jennifer felt that people were impressed by her PhD degree. She explicitly stated that she encountered no negative gender- science stereotyping, she felt this was because she was surrounded by STEM people: *"few women in STEM class...first of all, people don't know anything about what I am studying when I talk to them...when it comes to STEM PhD, they are impressed (think I am really good)!... I haven't encountered any negative stereotype...this might be people around me, most of them are from academic area of STEM, they seem shocked by the PhD degree not what subjects I am in..."* (line 45-50). Jenifer talked about her PhD experiences with colleagues in the UK, she felt she received respect and that made her very proud of herself.

While back in China's small cities, she felt she might have received some negative gender stereotyping, but for being a female PhD, rather than because of her subject of study. Also, she thought that women in STEM did not care as much about their appearance as women in humanities do because it is not convenient for their work: *"…also it depends on where people from, people will understand if they come from big city, like Beijing. However, if they come from smaller cities: they will confuse why did I do PhD, after finishing PhD, I am older, it was not a girl supposed to do"(*line 51-54). The concentration of discussion transferred into women facing the 'threats' of aging, marriage, and other traditional family aspects for women. From Jennifer herself to her social role in the Chinese family, the disappointing point she felt might come from less respect for what she had done to improve herself and achieve this career than for choosing to have a family. Jennifer as an individual seemed neglected by people and pushed her to merged into a big traditional Chinese women group.

Thus, Jennifer did have stereotypical associations, particularly regarding appearances, for women in STEM fields: *"I thought women in STEM are not caring about their appearance, not meaning they are messy, not dressing up a girl. Women in Humanities are taking care about their appearances...I am doing experiments every day with chemistry and instruments,* *if get on rings or bracelets will be messy. Woman in Humanities won't worry about these issues...I need take them off every time I am doing experiments."* (line 67-71). She explained these appearance differences with other non-STEM female researchers, trying to distinguish herself or STEM women from standard women's appearances.

7.7.4.7 Difficulties and conquer

As she encountered a less encouraging and pressuring environment in her PhD studies in China, Jennifer considered giving up her research. *"I was thinking about giving up when the process was not as you expected, or you are not good at something. I was not very good at specific subjects very badly...also I was asked to get publications when I was doing PhD if not, I would fail PhD, I was so depressed and stressful"* (line 57-61). She finally got through and kept going. The reason for this might have been that she faced much more stress doing a PhD in China, where she had to publish three articles, among other external metrics of 'successes. Jennifer did not give clear answers on how she went through these diffusivities, however, she said: *"need to more active thinking, for STEM researchers, they need be patient and tolerant of loneliness...I did experiments with mirrors, need extremely careful and patient with adjustments"* (line 57-61). These personality characteristics might be the reason why she finally persevered, but it is clear she is also resilient.

7.7.4.8 Family-career balance

Jennifer would give up part of her work to spend time with her family when she was doing her PhD in China. This was quite like others, such as Sophia. She was quite sure that she would sacrifice part of her work because she would much more treasure the time spent with her family. Also, she noted that the two countries have different lifestyles. *"it depends on what you purse, if you would like to pursue a much higher achievement, that would definitely be sacrificing, because it needs more time to do. I won't sacrifice that much. I hope I could spend time with my family when weekends come. The reason why is that I used to be working 6 days a week in*

China, always stay up late for work, I would break that. If I would a family, I need to give up part of my career" (line 57-61).

7.7.4.9 Differences between the UK and China

In the UK, the working lifestyle she felt was totally different from China's. She perceived work and home life as more separate. *"In UK, work and life are quite separate here. In China, you have no choice, you have to be ready to work at any time. In UK, I feel relax. But I have families in China, I need go back. Here (UK) is better nicer for me, regarding of life and work..."* (line 84-87). In the UK, Jennifer felt she no longer suffered as much from social expectations. People in the UK, she felt, paid less attention to your gender than to what you are doing- revealing a consistent theme that perceptions of stereotypes and sexism as perceived as weaker in the UK. Even if they do hold stereotypes in the UK, she flet they would not tell you. Therefore, Jennifer found life better in the UK in terms of both her private life and work.

In China, being 'safe' (women) means getting married as soon as possible: *"in China, they expected me to get married immediately after I graduated from PhD, but I haven't had these expectations here"* (line 90-91). She felt she would *have* to find a partner after completing her PhD, but in the UK, she felt there was no such pressure. Apparently, she did not consider marrying as soon as she completed her PhD (she was still single at the time of the study). Nevertheless, she did worry a little about these things, especially when thinking that she would need to return to China for her family's sake. Also, people in China, she felt had certain stereotypes of what represent good and bad subject of study for women- which in and of itself is acknowledgement of gender-STEM stereotyped associations. According to society's expectations, women should not do work in fields that are traditionally male dominated, such as outside work. Thus, STEM is not seen as a good choice for women. Some encourage women study STEM, to get an easier job, not with higher expectations from parents. In general, Jennifer felt that people from both countries shared the same stereotypes of female PhDs, or of PhDs in general. She seemed rather confused by this observation.

7.7.4.10 Advice for girls interested in STEM

Jennifer was aware that there were certain difficulties for women stepping into STEM in China. In China, girls are told that they are not as good as boys when they pursue higher positions in education or in their careers*: "Be bold! in China, people don't think girls could be on the top position because it's getting harder when women pursue higher position for their career. For instance, research, especially in STEM. This stereotype for girls were spread so widely when I was in high school...it might be someone break this "law" but it's no nothing about gender...in China, people don't prefer women has a high-education background, master's degree will do the trick." (*line 104-110).

So, Jennifer encouraged girls who might be interested in STEM to be bold and not afraid to 'break that lie'. She noted the even worse pressure that comes from supervisors, reflecting the gender stereotype common in Chinese society: *"I remembered that if some new female Postgraduate researcher student, the first thing supervisor asked would be: "have you got a boyfriend?" "are you going to be having a baby during PhD?"* (line 111-113). She highlighted that female PhDs must understand the cost of taking all that criticism from society and also potentially from inside your family. She was very aware of the pressure on women with high-education level coming from the people around them, influenced by the majority of society.

7.7.4.11 Summary of Jennifer

Jennifer demonstrated rather distinctive views about where she stood but were very much in line with the other interviewees. She strongly associated men with science and liked challenging (powerful) jobs. She thought she it was because she had a man's character and played with boys' toys that she much preferred STEM to the humanities. Since humanities subjects 'were for girls', she preferred the 'challenge' of STEM subjects. Another reason why she chose STEM was because of the separation of science and art at high school. She loved maths and had rather good grades in the subject. Also, she had a very clear version of her career and was ambitious.

She had a rather pleasant childhood (she compared herself with her peers). Although her parents had lower expectations for her, she seemed to be strictly self-disciplined and enjoyed challenges. Her career ambitions and what she had already achieved in her field differed from her parents' expectations for her. She was a little rebellious in her thought: whatever she 'should be, she felt she would be the opposite.

Jennifer was slightly different from the other Chinese participants in interviews, in that she did not move abroad to study and work until she had finished her PhD degree in China. Therefore, she had experience as a Chinese woman with a Chinese PhD degree as well as of working in the UK in STEM. That could partly explain why she seemed to have experience much more stress and difficulties during her STEM educational trajectory in China.

Jennifer claimed that she had experienced no gender-science stereotypes in China or in the UK, and yet had strong think STEM-think male biases, but she felt she was protected from stereotypes because she was working with only STEM people. Also, she had received positive comments about being a female STEM PhD. Jennifer tended to be quiet and focused on her work as a researcher in academia, rather than on the office life. She would like to stay in the UK because she viewed it as offering her both better work and a better life than China could.

7.7.5 Cross-case Summary and Discussion of Findings

The last step of IPA involves looking for patterns across all cases. Thus, this section discusses the common themes emerging from the four interview cases. In general, even though the different Chinese participants had taken various pathways to their STEM careers so far, some common and similar experiences were mentioned by all of them during the interviews. The common themes and patterns emerging from the four participants are summarised in the following sections.

7.7.5.1 Reasons for choosing STEM

All four participants showed "natural" interests in maths or science that were strongly advocated by their families. An interest in maths or science as a girl might be essential as it seems to indicate to potential for a future STEM career (see review in Kier, Blanchard, Osborne, & Albert, 2014). For some participants, their interests emerged very late (after undergraduate studies). However, there was no evidence to suggest that the timing of becoming interested in maths or science might play a key role in their career choice.

Eventually, most participants chose STEM as a career because they were interested in how they could apply STEM subjects to help people in the real world, as well as advancing into high status and well-paid careers. The CCEE exam also emerged as a strong motivator for choosing science subjects over humanities subjects – i.e. going with aptitude (their academic strengths). The impact of parental pressure added yet another layer, with many of the Chinese participants saying that they had taken their parents' advice into account, and some coming to regret their choices. The main reason for this was that they knew little about their possible future careers or even the subjects they were choosing to study. Although this situation has improved in recent times thanks to the internet, women still need direction during this decision-making stage. In sum, all participants pursued their interest STEM and established a STEM career that they were proud of. However, they all expressed doubts and insecurity about navigating their STEM careers due to a lack female role models along their educational and career pathways.

7.7.5.2 Agentic personality traits for Chinese women conducive to success in STEM

All four participants talked about how Chinese women in STEM tended to show similar characteristics valuable for pursuing careers as female researchers. Some characteristics that participants identified as needing to be possessed were being persistent, working hard, never giving up, and being sentimental. In other words, they showed bias toward 'think-STEM, think-male'. That is, thinking that having traits opposite those of 'traditional women' were better for STEM success and undervaluing the more 'communal' traits that also emerged as relevant for success (e.g. being warm, optimistic, and lending support to future women coming up the educational and career ladder). Some of these personality traits are considered special characteristics of women in general (Cao, 2019), as well as gender stereotypes (e.g. women working in STEM tend to have better studying skills and wear no make-up[17], a stereotype that was overwhelmingly contradicted by the participants in the interviews). These personality traits can enhance women's STEM identity, as having an identity that is incompatible with the STEM identity would represent a significant impediment to women engaging with STEM and having success in the field (Settles, 2004). This compatibility between gender identity and STEM might help women engage with STEM and ensure better performance as female scientists (Settles, Jellison, & Pratt-Hyatt, 2009).

7.7.5.3 No perceived experience of stereotyping of women in STEM: Environment

The most remarkable finding across cases is that all four participants explicitly claimed not to have experienced any stereotyping of women in STEM, as well as making stereotype-consistent attributions of what science and humanities studies are, and what researchers in these categories 'look like'. Although they acknowledged that stereotyping of women existed in their home culture/society – and to a lesser extent – in their host country of the UK, they saw this phenomenon in the context of 'other women' around them, or even prior generations.

[17] These gender stereotypes relating to women's appearance are also found in relation to female leaders

Participants usually mentioned their own protective 'special' masculine/agentic characteristics as reasons for not encountering any stereotyping. They also gave two main reasons for not encountering it within their fields. First, people they came into contact with everyday were mostly from their fields of work (i.e. they might not show their stereotyping directly), and if anything would value them more for being successful STEM researchers, even in a male-dominated field (i.e. they would see them as 'exceptional women'). Second, they worked in the UK context wherein people are less likely to express overt sexism (e.g. they felt their colleagues tended to keep their opinions to themselves), in contrast to small villages in China.

On one hand, this finding makes sense because these women have already achieved successful careers in STEM fields as independent researchers. However, what was unexpected was that they constantly noted not encountering any gender-STEM stereotypes when they were growing up. A social psychological explanation for their lack of explicit gender-stereotype experiences is that of cognitive dissonance. That is, it is possible that participants dismiss gender discrimination toward them as admitting these could be seen as a weakness and would contrary to their 'strong' and resilient image.

7.7.5.4 Sticky floor 1: Sacrificing for family-career balance

All four participants expressed the need to sacrifice their careers for the sake of their families - i.e. the family always came first. In terms of the family-work balance, they had different levels of expectations for their careers - ranging from having no job at all to keeping at least some form of part-time work. Although they all wished to have both a fine family life and a full-time/proper job, they felt women with STEM careers would be judged for not attending to their families as much as other women do. Participants also stated that their ideal job would be as researchers since it constitutes a stable kind of job that conforms to Chinese traditional expectations for women – e.g. working in academia could be simpler to handle as its few socialising requirements would leave more time for the family. Although this represented a certain kind of contradiction for those who held high career ambitions, participants were ready to sacrifice their careers thereby showing the strength of cultural and family gender-role pressures women face, even when already working successfully in their chosen fields.

7.7.5.5 Sticky floor 2: Marriage anxiety induced by parents and society

Another issue connected with family-career balance was the anxiety induced by the expectation that Chinese women should be married at a certain age and attend to their families more than men do. Participants not only felt this pressure from wider society but also, and mainly, from their parents and other important people in their lives. Participants also stated that although their families advocated for their 'success' working in STEM, their parents had lower expectations for their careers (as 'daughters'). Overall, these forces pushed these women to fit into a certain form of being a Chinese woman – e.g. women should not have a higher position than their husbands in any aspect, women should not have too much ambition for their careers.

7.7.5.6 Sticky floor 3: Parents' impact and influence

Echoing Chinese focus group participants, interviewees disclosed the impact of their parents on their overall growth and career ambitions in STEM. Their parents considered the issue from two perspectives: (1) whether or not this major would allow easy access to a job, which could affect their future careers; (2) whether this major fit society's expectations of women, which could affect their marriage prospects. Although they were free to choose their majors based on their own interests, the turning point was the CCEE. Since being STEM majors might make it easier for them to get a job, their parents encouraged them to follow their STEM interests. However, when participants wanted to pursue a more advanced career in STEM through higher academic studies (PhD), their parents discouraged them since pursuit of a more advanced career did not match society's expectations of Chinese women (e.g. it would cause problems in marriage).

7.7.5.7 Discussion of family roles for women with work

When it came to discussing issues related to the work-family balance, all of the participants noted radically different situations in the UK and in China. Chinese women felt they tended to take on certain roles in the family. This might partly explain why women studying STEM subjects in the UK felt better able to balance their work and their family life. In the UK, they felt women were more flexible, for instance to take on a part-time job or share with their partners, to allow them to attend to their families. They felt they still might still miss out on career opportunities if they chose to have a baby, but this would be easier in the UK, where men they felt could assume equal responsibilities with women for looking after the family. Whereas, as women in China they felt they would have to take on more responsibilities for the family, they would have to sacrifice their career in order to have a family life. This essential cultural difference affecting women in STEM in the two countries was essentially due to the different conceptions of the woman’s role in the family.

Different conceptions appear of the woman’s role in the family. Given these cultural differences between UK and Chinese women in our sample, it would appear that some Chinese women in STEM fields report feeling more vulnerable in their working environments. At the same time, they may be subjected to the pressure of social expectations, particularly traditional Chinese family conceptions, but also British stereotypes of Chinese women. These nationally proscribed expectation might explain some of the choices they made, such as acknowledging a need to sacrifice their careers more for their families or being positive and optimistic even in male-dominated research environments.

In terms of the family-work balance tensions discussed in the previous sections, the reasons for these problems emerged rather clearly in the interviews from the participants’ multiple perspectives. The conflicts mainly arose from women in STEM in China wishing to devote themselves to a professional career. Thus, a choice may have gone against their current social expectations, from family or even friends in China, as well as many aspects of their cultural traditions. Given the different conditions in the two countries for women working in STEM, most of the participants revealed a high level of anxiety about the prospect of returning to China to work, and preferred to stay in the UK, where they felt they could enjoy a better working environment, despite some acknowledging stereotypes in the UK toward Asian women in general.

7.7.5.8 Inter/micro-cultural differences experiencing in the UK

All four participants experienced living and working in China and the UK. They highlighted differences across countries, especially in relation to lifestyle and working conditions. Given differential conditions in the two countries for women working in STEM, most participants revealed a high level of anxiety about the prospect of returning to China to work and preferred to stay in the UK - where they felt they could enjoy a better working environment, despite UK cultural stereotypes toward Asian women in general. The following subsections summarise the key inter-cultural differences participants highlighted:

7.7.5.8.1 Contrasting impressions of women with a professional education degree

All four participants had PhD degrees and had experienced contrasting reactions to their education backgrounds in the two countries. In the UK, people appeared to be impressed by how brilliant and smart they were. However, this was the opposite in China as Chinese people were intimidated by the fact that they were female PhDs.

7.7.5.8.2 Differences in working environment

Participants perceived the STEM working environment for women as relatively friendly in the UK. Colleagues were seen to care less about others' lifestyles, whether they are women or men. And even if they might judge women in the workplace, participants felt that colleagues would keep it to themselves. Participants also felt that any bias or prejudice they encountered in the

UK was due to nationality rather than biological sex. Even though men dominate the core roles in 'hard' STEM fields, they noted that many significant roles in applied STEM fields are now occupied by female researchers, which could inspire other women in the UK's STEM sector to develop more promising careers. Therefore, participants all expressed keenness in passing on their experience and opportunities to future women STEM researchers.

In contrast, participants felt bias toward women PhD researchers more keenly in China, regardless of the subject/field of study. Thus, STEM environments were generally portrayed as less friendly for women in China. Moreover, participants felt that Chinese women in STEM may feel pressured to meet the 'standard criteria' of women in Chinese society and thus experienced a great deal of stress as a result of both societal and family expectations. Female role models in STEM were also lacking in China as women are still discouraged from pursuing a professional career in STEM fields.

7.7.5.8.3 Differences in women's responsibilities and role within the family

All four participants noted radically different situations between countries when it came to issues related to work-family balance. In general, participants felt better able to balance their work and their family life within the UK context. They felt that women in the UK were more given more flexibility to take on part-time jobs or to share family caring responsibilities with their partners. Although participants felt that they might still miss out on career opportunities if they choose to have kids, they felt that this would be easier in the UK since it is more acceptable for men to assume equal responsibilities in looking after the family. In contrast, participants felt the need to sacrifice their careers in order to have a family life within the Chinese context as women in China are expected to take on more responsibilities for the family.

7.8 Discussion of Interview

The themes and sub-themes which emerged from the IPA for the Chinese women working in STEM were as follows (themes could be found in Table 12-10.3). Some of the themes and sub-themes were found quite consistently in the focus groups. As the interviews just concentrated on Chinese women's working conditions, this might reveal more detailed understandings. The first theme that emerged regarded ***Interest and comfort in STEM: women's interests in maths or science.*** For some of the women, their interests emerged very late (after undergraduate studies). There was a wider range of times at which interest in STEM emerged among the Chinese women compared with the UK group. However, there was no evidence to suggest that the timing of becoming interested in maths or science might play a key role in their career choice. Those that found an interest in STEM at a later stage might have been "hiding" it as their parents might have discouraged such interests (Shapiro & Williams, 2012); these Chinese women might not have received any encouragement to develop their maths performance when growing up. Regarding the second theme: ***why they chose STEM as their careers***, the reasons were quite similar to their own interests and for jobs. Although many factors might affect their STEM career choices, an interest in maths or science as a girl might be essential as it seems to indicate to potential for a future STEM career (see review in Kier, Blanchard, Osborne, & Albert, 2014). In their choices, they considered their CCEE prospects, and their own interests might not have been their main priority, as the participants noted. The timing of the Chinese participants making their career choices (post-high school) and their reasons for doing so were always highly related to their future jobs (i.e., income/status). The impact of parental pressure added yet another layer, with many of the Chinese participants saying that they had taken their parents' career advice into account, and some coming to regret their choices. The main reason for this was that they knew little about their possible future careers or even the subjects they were choosing to study. Although this situation has improved in recent times thanks to the internet, women still need direction during this decision-making stage. The third theme was: ***Agentic personality traits for success in STEM fields.*** Some characteristics that the women identified as needing to be possessed were being persistent, working hard, never giving up, and being sentimental. These findings were unexpected; the women in STEM saw these traits as necessary in order to get through the difficult times (e.g., giving up their study and research). Some of these personality traits are considered special characteristics of women in general (Cao, 2019), and also stereotypes of women. Moreover, some research has found that according to gender stereotypes regarding the personality and appearance of Chinese women working in

STEM, women working in STEM tend to have better studying skills and wear no make-up, a stereotype that was overwhelmingly contradicted by the participants in the interviews. However, we also found that these personality traits could enhance women's STEM-identity, as having an identity that is incompatible with the STEM-identity would represent a significant impediment to women engaging with STEM and having success in the field (Settles, 2004). This compatibility between gender identity and STEM might help women engage with STEM, such as by increasing their identity and ensuring better performance of female scientists (Settles, Jellison, & Pratt-Hyatt, 2009). Moreover, these gender stereotypes relating to women's appearance are also to be found in relation to female leaders. As this STEM-identity is part of the main triangulation discussion, more details will be provided later. The next identified theme was similar to one found in the focus group: the unexpected ***cognitive dissonance*** found among Chinese women working in STEM fields. At first glance, it makes sense because these women have already achieved successful careers in STEM fields as independent researchers. However, they constantly noted that they had not encountered any gender-STEM stereotypes when they were growing up. This surprising conflict was found in the results, as will be explored further in chapter 8. The last theme to emerge from the interviews regarded the ***intercultural differences*** that the participants experienced between the UK and China. In the UK, they tended to find more women-friendly working environments, and higher aspirations and expectations for their careers. The starkest difference that emerged was that for the Chinese women, all of their career ambitions vanished when it came to have a family, which made them impossible. They were willing to sacrifice their careers for their families in the future. Besides, the consistence with last themes of "having gender stereotypes", the impact of traditional Chinese culture still plays a role when it comes to gender roles in families. This will be further unpacked in the triangulation discussion about the cultural differences between Chinese and UK women.

8. CHAPTER EIGHT: TRIANGULATION DISCUSSSION

8.1 Thesis Overview

Women's underrepresentation in STEM fields remains a worldwide phenomenon. In the previous chapters, I built up a framework of social-cognitive cross-cultural theories to guide us in understanding women's own gender-STEM stereotypes and their experiences of gender-STEM stereotypes. Women studying in STEM fields from both nations faced a similar issue. However, it seems that they have differential influencing factors because of cultural differences influencing different gendered identities, especially Chinese women, with a large impact from Chinese traditions still held implicitly.

This thesis addressed four overarching aims using a sequential explanatory mixed-method design with three studies across two phases. All participants were female students in the UK and China: university students in Phase One and PhD and post-graduate researchers in Phase Two. The aim of this final chapter is to discuss and integrate all the findings from the three studies to address the aims of the thesis, situate these within the literature, and explore their implications.

8.1.1 Study 1 Summary: Implicit and Explicit Gender-STEM Stereotypes

The first quantitative study analyses revealed that the women in this cohort did, on average, hold implicit and explicit gendered attitudes towards women working in STEM fields (when compared to other generalisable study standards). There was a weak positive correlation between these two types of stereotypes- explicit and implicit gender-STEM attitudes- which suggests that one's implicit gendered attitudes are to some extent linked with one's explicit attitudes, although they may indeed tap different cognitive and affective aspects of gendered stereotypes; with the former more likely developmentally and culturally ingrained at a sub-conscious level, and the latter more consciously constructed through experience.

The extent of the gender-STEM stereotypes was further shown to vary between the different cohort sub-groups. For instance, explicit gender-STEM attitudes revealed international differences, such that the Chinese women in the sample tended to report higher levels of explicit gender-STEM stereotyped attitudes than women in the UK. At the same time, there were consistent differences depending upon subject of study on explicit attitudes, which revealed that regardless of nationality, women studying STEM subjects reported less explicit gender-STEM stereotypes than women in non-STEM fields. There were no interactions between nationality and subject of study, nor was there a significant planned contrast for intra-national group differences in the Chinese women on explicit attitudes, but there were intra-national differences whereby Chinese women not studying STEM did indeed hold stronger implicit gender-STEM stereotypes.

8.1.2 Study 2 Summary: British and Chinese Women Studying in STEM Subjects

The themes and sub-themes (see *Figure 23-6.1*) that emerged from the thematic analysis of the focus groups with Chinese women studying STEM were as follows. These themes were discussed in chapter 6, but to re-cap the first main theme related to the ***factors that influence women who study in STEM fields***. Four sub-themes were revealed to explain main influential factors. Briefly these were labelled as facilitating factors guide the overall qualitative analysis below, embedding STEM interests early, reasons for choosing STEM with internal and external motivations, female role models and subscribing given to a 'personality of strength' for STEM were all emergent. The second main theme was ***experiences of stereotyping for women in STEM***, which related to women confronting sexism, their experiencing of stereotypes and advice for women would in STEM fields. The last main theme was the ***cultural connotations of STEM***, which were largely centred around barriers Chinese and British women were facing during their STEM studying, but these diverged for each national focus group cohort into concepts I termed "Sticky Floor" versus "Glass Ceiling". All these themes were discussed in detail in the end of chapter 6, and I will expand and collaborate in the overarching aims sections with overall thesis' findings below.

8.1.3 Study 3 Summary: Chinese Women Working in STEM Fields at Earlier Career Stage

This study mainly focused how Chinese women maintain and persevere once working in STEM fields, specifically at their earlier working stage in the UK as post-docs or ECRs. Using IPA to interpret each STEM journey and experience through their positions, main common findings were discussed in chapter 7. Briefly, these included 'natural' interests in math and science even if it came later, perceiving internal motivations, but strongly discussing external social norms, when discussing why they chose STEM as career, in addition 'personality of strength' emerged here also for perceptions of success in STEM fields- but this was alongside a strong sense of the need for resilience and other communal factors, such as support showing that traditionally more feminine traits were evident but dismissed as less valuable. Still, Chinese women in working status were facing the same issue from 'ground floor', the differences between studying status were closer to the concern about marriage and family-work tension. Also, some surprising contrasts emerged and were discussed; namely, cognitive dissonance, from the focus groups and interviews often emerged similar statements such as 'I haven't encountered any gender-STEM stereotyping experiences. However, while they mentioned not encountering gender-STEM stereotypes, they were aware that they were experienced by other women around them, as well as general gender stereotypes. These contradictory cognitions are defined as contractionary narratives, which individuals feel uncomfortable or pleasant conditions, they would resolve these with altering their cognitions (Festinger, 1957). Cognitive dissonance was consisted of denial of facing stereotypes growing up, or sexism explicitly in their workplace-even perceiving 'positive discrimination' as a woman applying for research jobs, alongside clear evidence of adhering to gender-STEM stereotyped content and examples of being treated differently.

As well as the concept of perceiving intercultural differences in prejudice (i.e., perceiving there were no stereotypes in the UK), alongside facing examples of felt prejudiced toward them, and assumptions made about them as Chinese women researchers. As the last part of the research, will mainly expand in overarching aim 4 to complete the whole trajectory of Chinese women in STEM fields up to earlier career.

8.2 Triangulation Discussion

Guided by the overarching aims of thesis, this section will triangulate what I learned across the three studies. From women's broad gender-STEM stereotypes, attitudes towards women in STEM fields, and their own felt experiences of these concepts, to explore women studying in STEM from both nations, narrowing down to the experience of Chinese women working at earlier stage in STEM career, all these enriching and building up the pathway (in *Figure 14-8.1*) facilitators and barriers for women in STEM fields in this research.

8.2.1 Overarching Aim 1: Evaluating the influence of implicit and explicit gender-STEM stereotypes on women's subject of study choices

Taking a broad approach, Overarching Aim 1 focused on *evaluating the influence of implicit and explicit gender-STEM stereotypes on women's subject of study in the UK and China, especially investigating Chinese intra-national differences between STEM and non-STEM students.* Overall, quantitative results (Study 1) suggested implicit and explicit attitude in STEM fields. Supporting these results, conceptions of implicit and explicit gender-STEM stereotypes also emerged consistently across qualitative studies.

Regardless of different subjects of study and nations, triangulated findings suggested that women in this cohort held both implicit and explicit gendered stereotypes associated with STEM. Although this was higher for women not studying and working in STEM, it was clear that there was self-adherence to stereotyped beliefs in terms of what a woman successfully working in STEM should look like (not girlie), act like (agentic, strong) and behave like (get along with others and leave issues like sexism). This consistent finding of subtle and blatant stereotyped attitudes emerging within this cohort plausibly explains empirical data (OECD, 2018) of why women "drop" and leave STEM fields across nations. In other words, in line with previous literature (e.g. Smeding, 2012), it seems that British and Chinese women have internalised these gender-STEM stereotypes, especially for those in non-STEM groups.

As expected, Chinese women showed greater explicit stereotypes overall, but those not studying STEM held greater on implicit attitudes, as well as greater internalised stereotypes. This finding is in line with French research on implicit attitudes between STEM and non-STEM students (Forgasz et al., 2014). This bought in our main concern as to how these women developed these gender-STEM stereotypes, and what the subsequent impact of these internalised cognitions and attitudes might be on women in choosing and maintaining a career in STEM fields (Shaw & Stanton, 2012). It seems that gendered associations, say of certain masculine/agentic traits with what it means to study and work in STEM, appear to have been internalised early-on. Although the women in this study did not acknowledge that these stereotypes influenced their study decisions and career paths, results suggest that they nevertheless play a role in explicit and implicit biases, even for women who study STEM, and particularly for Chinese women, for whom this stereotype might have unconsciously influenced their decisions not to study STEM.

Indeed, there were national differences in levels of explicit attitudes. As hypothesised, Chinese women reported higher explicit gender-STEM stereotypes than British women in the survey cohort. This quantitative finding was corroborated in the focus groups. Consistent with the literature, implicit attitudes developed at more unconscious level largely affected by culture and the environment women grew up in (e.g. Li, 1999; Gunderson et al., 2012). On the other hand, explicit attitudes developed on a more conscious level and relied more on experiences (e.g. Herrmann et al., 2016). In both the interviews and focus groups, participants often explicitly stated they had not encountered any gender-STEM stereotypes when they were growing up, nor in their institutions of study and work, but that they were aware that they existed at the broader cultural level - and they sought intentionally to not conform to what it meant to be a 'girl'. This was specifically the case among ECRs who sought not to look, dress, act or appear like a 'girl', as they perceived someone in Humanities would be more 'girlie' than someone in STEM. This particular result can be linked to ***reactance to stereotype*** (or acceptance of stereotype); that is, when gender stereotypes were activated implicitly, participants exhibited stereotype reactance (Kray, Thompson, & Galinsky, 2001). But why did they appear to accept this gender-stereotype threat explicitly? Following Lemus, Bukowski, Spears and Telga's (2015) explanation on different gender beliefs among women, when women with more traditional gender beliefs are exposed to gender stereotypes, they react by legitimising the threat. In contrast, women with more progressive gender beliefs (feminist identifiers) persist to solve the threat by reacting against it. In other words, Chinese women denied the existence gender stereotypes which could expand more explanations on individual cognitive level (e.g., cognitive dissonance) with cultural and intercultural differences, which will address in Overarching Aim 4. Therefore, identify what factors have impact on women in STEM fields, their real experiencing about gender-STEM stereotypes, especially Chinese women in STEM fields.

8.2.2 Overarching Aim 2: Identifying key facilitators, barriers and transition points for women's STEM progression

Building on Overarching Aim 1, ***Overarching Aim 2*** focused on *exploring additional factors that positively influenced women's decisions to study STEM leading up to their postgraduate studies in the UK, and identifying key facilitators, barriers and transition points that supported both British and Chinese women's progression in STEM at the postgraduate level and beyond*. Collectively, triangulated results from all three studies indicated several key facilitators encountered by women studying in STEM fields.

Firstly, their own self-perceived 'natural' interests to math and science were mentioned across the focus groups and interviews from both nations, which can be seen as internal motivation (Shapiro & Williams, 2012) that developed among participants since they were young. However, they also discussed receiving strong social supports for studying STEM from parents and teachers who clearly valued STEM over non-STEM fields because of its association with successful life outcomes like job security and income (Cao, 2019) and encouraged them into pursuing STEM fields. In other words, it can be said that internal-external motivation (e.g. teachers; Li, 1999) and SSSRM (Herrmann et al., 2016) positively impacted these women studying STEM and facilitated their STEM pathway decisions.

However, it is worth noting that there could be international differences among British women and Chinese women when considering more specific social pressures, social norms, and external motivations. For example, Chinese women studying in STEM fields might carry different expectations from their families (as evidenced in Chapters 6 and 7). This appeared to be an additional factor that was positively influential to Chinese women studying in STEM fields, but could also act as a barrier to them leaving STEM study even if their interest in the field had waned. Indeed, most of the Chinese women in the qualitative phases were not only positively reinforced but showed contradiction when considering later career development. For instance, if a teacher is not supportive to women studying in STEM or if studying STEM conflicted with their families' wishes, this could reduce their motivation to pursue a STEM career. This could explain why learning about STEM gender biases can help women overcome such biases and improve their self-confidence in pursuing a STEM career (Weisgram & Bigler, 2007).

Likewise, there were some 'reversed barriers' between the two national samples, partly because of the impact of different cultures, and partly perhaps because one cohort was studying in their home country while the other was working and studying far away from home. This was best encapsulated by the Chinese women in our cohort expressing most of their pressures from "the sticky floor" that is families and home country networks (see Chapters 6-7). On the other hand, the UK cohort's experiences can better be described as more 'women-friendly' concerning the conception of STEM-working environments, with higher familial career aspirations and expectations.

8.2.3 Overarching Aim 3: Underlying factors, and wider cultural influence on career progression and maintenance in STEM

Taking a closer look at the STEM pathway of Chinese women, ***Overarching Aim 3*** involved an *in-depth investigation of the underlying factors influencing Chinese women's decisions to pursue and maintain high-level STEM careers in the UK, considering wider cultural and family influence on career progression and maintenance*. For this stage, the focus was on early-career Chinese women (e.g. post-doc) in STEM fields. Overall, participants were influenced by similar cultural factors, most especially by their families. Participants also exhibited cognitive dissonance in relation to facing sexism and prejudice as women associated with STEM. The next two sections will discuss each of these issues in relation to the pathway.

8.2.3.1 Progression issue: "Glass ceilings" (inter-national differences)

The main cultural differences emerging in this research are summarised here in terms of the types of difficulties faced by the two national groups during their careers. The "glass ceiling" is used as a metaphor here to represent the many obstacles women might face when pursuing top careers (Cotter, Hermsen, Ovadia & Vanneman, 2001). In this study, this issue was noted by the UK cohort when they described experiencing increasing external obstacles – largely institutional barriers with some perceived cultural obstacles – as they tried progressing into their higher educational and career goals. This can be linked back to the lack of female role models and well-developed female networks (Shaw & Stanton, 2012; Lido, Gauchotte-Lindsay, Cebul, Mulvana, Jebsen, Hedge, Chalmers & Renshaw, 2022) at higher levels of studying and working in STEM.

In addition, 'male privilege' was another issue reported in hard science STEM fields. In the UK focus groups, **'Man is the gatekeeper'** was a phrase participants agreed on to encapsulate their view of progression and maintenance in the STEM study-work pipeline as they found this phenomenon in all STEM fields. Participants noted that even when women put in more effort than men, they still might not attain the same level of achievement as their male counterparts, especially when it comes to top positions in the hard sciences. In other words, women do not seem to have the opportunity to succeed at top positions as easily as men. Moreover, they tend to face role incongruity (i.e. having to dress like men and not be feminine; dressing like women is not permitted in leadership positions), which can lead to some women finding it hard to fit into leadership roles (Heilman, 2001; Eagly et al., 2014). For example, the British women in this study struggled with male-dominated environments and said that they felt uncomfortable when they saw no other female colleagues around. This finding can be linked to other studies showing that female researchers in the fields of physics and engineering tend to have minimal social networks (Cebula et al., 2019). For females with a PhD in the STEM fields, research points out that female scientists have been left out, which might be caused by other issues of gender discrimination within academia, such as through grant agencies, journal reviewers and search committees (Ceci & Williams, 2010). Thus, women in STEM higher education and careers might need same gender social support from their environments.

8.2.3.2 Progression issue: "Sticky floors" (inter-national differences)

On the other hand, **'I will sacrifice my career for my family'** was a sentence frequently mentioned by Chinese women to describe the tension between their family and career. In contrast to their UK counterparts, the Chinese women in this study highlighted difficulties in earlier stages, particularly when they had to choose between family and career. That is, even if they could reach a higher position in their STEM careers, their career ambitions vanished when it came to discussions of having a family in the future. Although the issue of balancing family and career responsibilities is also common among women in Western settings (Greenhaus & Parasuraman, 1999), the tension of ***family-career balance*** was particularly salient among the Chinese cohort in this research as they often connected their careers with their responsibility to family. That is, their first priority was often 'family' as they expressed willingness to either give up or to diminish the importance of their career in order to 'fit' into their expected gender role (i.e. as mothers and wives) within the family.

Unlike the British cohort who highlighted institutional obstacles related to male privilege and the glass ceiling, the Chinese women in this research appeared willing to sacrifice their careers for their families in the future. That is, the issues they described seemed to stem from the ‘ground’ rather than the ‘ceiling’ in that the issues ‘exploded’ when they achieved higher degrees and careers and felt that they needed to make age-related decisions regarding getting married or having children (Chi & Li, 2008).

These findings can be linked to the stigmatisation of women with higher degrees in China as Chinese women with PhD degrees may be underestimated or undervalued by wider Chinese society (Chen & Courtwright, 2016; Deng, 2016) as a result of traditional female gender roles (e.g. beautiful wife in kitchen ads) propagated by the public media (Cao, 2019). Overall, the anxiety career-marriage issues induced appeared more common among the Chinese women in our sample. To some extent, this may be age-related – i.e. felt more keenly by those not married by their 30s. For instance, recent research by You & Hao (2020) found this was highly relevant with social trust for women regarding gender equity – e.g. the higher the degree Chinese women had, the lower rate of marriage in Chinese society.

Despite explicitly stating they had not encountered gender-STEM stereotypes, there is also much evidence of Chinese women having internalised gender-STEM stereotyped associations (e.g. think-STEM, think-male) and gender role expectations based on traditional Chinese culture. Chinese women in this research clearly valued masculinity over femininity (e.g. in traits and even appearance). However, the de-valuing seems only to come into play if they were to choose not to get married or have kids, as discussed above.

The traditional gender role for Chinese women is still often centred around bonding with other Chinese women. However, these Chinese participants seemed to be struggling and worrying about 'not working' fully after having their own children. The issues seem to stem from the 'ground' rather than the 'ceiling', in that the issues 'exploded' when women had achieved higher degrees and careers and felt they needed to make age- related decisions regarding getting married or having children. These findings might be highly related to stigmatisation of women with higher degrees in China. Stigmatisation happens when identify undesired characteristics as a result, narrow down identity (Chen & Courtwright, 2016). As Chinese women may be presented by the public media with negative female stereotypes, for instance the work of Cao (2019), which found women figures showed in advertisements enhanced the tradition female gender role in society (e.g., beautiful wife in kitchen ads). Chinese women with PhD degrees may be underestimated or undervalued by their wider society, and the underlying reasons might be a consideration of weakening a women's social status for gender-role inconsistent life pathways, which was for enhancing the statue of masculine in society (Deng, 2016).

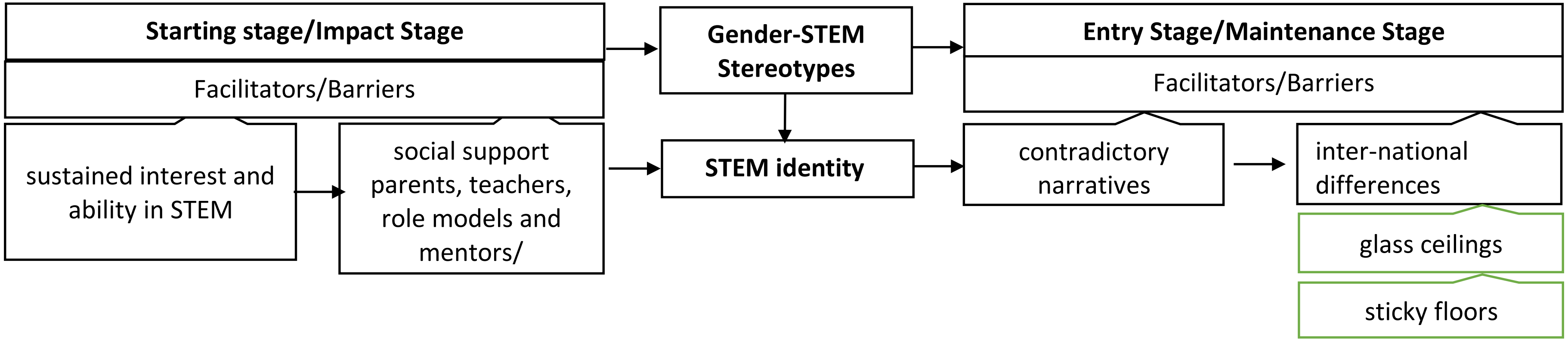
The career-marriage issue induces another anxiety for women, which appears to be more commonly found among Chinese women in our sample, and it may be age-related, for instance felt more keenly by those not married by their 30s'. Recent research by You & Hao (2020) did find this was highly relevant with social trust for women regarding of gender equity; the higher degree Chinese women had, the lower rate of marriage in Chinese society, suggesting why this might be problematic for a more communal society, reliant on wider familial networks for child-rearing and taking care of older relatives. However, Chinese women in this research clearly valued masculinity over femininity (i.e., in traits and even appearance), the de-valuing seems only to come into play if they were to choose not to get married or have kids, as discussed above, they were ready to 'sacrifice for family' in the future. This was closely linked to their gender role which deeply affected by their cultural upbringing, which will expend discussion with parents' impact in section below. Another point for Chinese women, was not based on their cultural upbringing but rather their STEM setting in the UK, in that they felt less pressure here as to whether or not they would get married and have children. This particular experience in a host culture let some to re-think the balance of family and work, aiming to achieve more equitable division of child and home labor, according to their experiences of working in the UK.

8.2.4 Overarching Aim 4-The Pathway Challenges for Chinese Women in STEM Fields.

Overarching Aim 4 explored the question '*how are Chinese women's work-life tensions, and more generally their internal-external motivations, influencing factors in achieving and maintaining successful careers in STEM fields?'* As discussed in Chapter 1, the analogy of a leaky pipeline in STEM is controversial. Nonetheless, it is useful here for identifying key transitions in the lives of the women who shared their experiences qualitatively in my sample. Collectively, women in STEM's experiences can be divided into several key time points: an impact stage, an entry stage, and a maintenance stage.

Figure 14-8.1 summarises the triangulated themes from the two phases of the study, while *Figure 12-8.1* outlines the different stages – showing the pathway of how women are impacted by their environments, how their gender STEM-identity is formed, and the challenges they meet in the later stages. It is important to note that women could potentially leave the STEM field at any of these stages.

Figure 14-8.1: The Pathway of Successful Women in STEM Fields



8.2.4.1 Challenge: the timing of the stages

Pell (1996) used the metaphor of a "leaky pipeline" to explore the ways in which women become underrepresented in STEM fields across transitional points in their life journey and how it can be fixed for female scientists in academia. She divided her research into four periods (i.e. early childhood, adolescence, college and graduate school). Similarly, another study on women's career choices and gender role also identified four different periods (Diekman, Steinberg, Brown, Belanger, & Clark, 2017).

The use of the "leaky pipeline" metaphor can be diverse. Applying it to this study, the pathway in my model (see *Figure 2-8.1*) can be divided into three stages: impact, entry, and maintenance. Although triangulated results indicated that all three stages were key points for women to have successful progression in STEM, I deemed the maintenance stage as particularly essential component given the study's primary interest in women's underrepresentation in STEM higher education and careers. Related to this, triangulated findings suggest that a 'STEM-identity' emerged as a kind of shield for women to avoid being "filtered out". Likewise, results relating to teachers' and parents' encouragement of women to study and work in STEM fields were also consistent with previous research suggesting that how women make their career decisions might have a crucial filter on their careers (Watt, et al., 2017) and that their career decisions might be affected by factors such as their parents and teachers (Shapiro & Williams, 2012). Although previous literature indicates that individual career interests or preferences might be one of the main reasons for choosing a career in STEM, my findings suggest that individual interest is not enough to sustain a career decision to stay in STEM. My findings echo previous studies suggesting that career-related decisions are affected by gender-related attitudes and self-concept, and even general life satisfaction (e.g. Jaensch, Hirschi, & Freund, 2015;

Li, Liu, & Song, 2021). Such internalised gender-STEM stereotypes could impair women's aspirations of a career in STEM (Schuster & Martiny, 2017). More interestingly, it can also put women subscribing to these implicit gender-STEM associations into a narrower 'box' when they chose to study and work in STEM if they feel they must not conform to traditional female stereotypes in order to succeed.

8.2.4.2 Challenge: starting stages

Individual career interests or preferences might be one of the main reasons for choosing a career in STEM, but my research indicates it is not enough to make and sustain career decisions maintaining in STEM. Other researchers also suggested that career-related decisions are affected by gender-related attitudes and self-concept, and even general life satisfaction (Jaensch, Hirschi, & Freund, 2015). My findings echo this, as the prior over-arching aims outlined clear quantitative and qualitative evidence revealing internalised gender-STEM stereotypes, such that those studying STEM show bias toward thinking, playing behaving and dressing 'like a boy' rather than 'like a girl'. Li, Liu and Song (2021) suggested that gender self-stereotyping did not improve Chinese women's self-satisfaction, Chinese women were less affected by the traditional gender role because the current gender role of Chinese women rapidly changed in recent quarter (i.e., work independently as men). Thus, Chinese women were not internalised traditional gender roles into the current ones. Such internalised gender-STEM stereotypes, whether there is interest in STEM or not could impair the expectations of aspiration of a career in STEM (Schuster & Martiny, 2017). More interestingly, it could put women subscribing to these implicit gender-STEM associations into a narrower 'box' when they chose to study and work in STEM if they feel they must not conform to traditional female stereotypes in order to succeed.

8.2.4.3 Challenge: impact stages

Starting at the impact stage, findings suggest that the women in my research seemed deeply impacted by sociocultural factors during the process of gender socialisation from their own culture. They also picked up gender beliefs from their social environments, mainly from their families and teachers. At the same time, majority of participants felt they were 'naturally' interested in STEM fields and felt at ease there. They may have gradually formed their gender identity as a result of these impacts, including gender-STEM stereotypes that led to traits and behaviours they considered stereotype-inconsistent with women.

Although girls or female adolescents might become discouraged by the gender stereotypes in their environments (e.g. no female role models in STEM; Hattie, 2012), these findings were not echoed in my research as participants stated that they did not experience gender stereotypes and felt well supported in choosing STEM. Nevertheless, the impact of parents and teachers are still crucial in this period – i.e. if these influential people exhibit more subtle gendered attitudes, these might affect girls' maths performances and career expectations (e.g. Metheny, et al., 2008; Watt, et al., 2017). This might explain the presence of greater explicit gender-STEM attitudes of Chinese women, and greater implicit stereotypes for Chinese women not studying STEM.

8.2.4.4 Challenge: entry stages

The entry stage involves choosing a STEM career. This is when STEM-identity becomes stronger when encouragement is received from teachers and when better maths performances is achieved, leading to a sense of belonging to STEM fields. This stage is complex as the reasons why women choose a particular major was related to aspirations for their careers.

Both Chinese and British cohorts remained in their chosen STEM area at university for many reasons, but the primary reasons cited were external – e.g. future job stability and income. As noted previously, the Chinese cohort showed a much greater impact from their environments – i.e. social norms and influence from the family (as opposed to peers or even teachers), particularly their parents, as they had little knowledge before making their decisions. UK women tended to have multiple ways of trying to 'fit' into STEM fields, showing that belonging may be a barrier - and social Identity processes (Tajfel & Turner, 1986) might be a key mediator for women continuing in STEM at this stage. Chinese women seemed to be at a disadvantage in this respect because to buffer social identity threat, some factors might be important to female scientists: past experience with discrimination, positive experience with female role models, family support, and general social support were associated with a greater sense of belonging to maintain in STEM fields (Richman, Vandellen & Wood, 2011), which many Chinese participants did not have. Additionally, Chinese women found that working in STEM fields required less feminine appearances. This can be linked to Banchefsky, Westfall, Park & Judd's (2016) work showing that for women pursuing a STEM career, feminine appearance may erroneously signal that they were not well suited for science.

8.2.4.5 Challenge: maintenance stages

The last stage is the maintenance stage, which relates to remaining in higher levels of education[18] and into careers in their chosen STEM fields. Most of the concerns discussed in the previous two stages still affected women at this stage. However, their impact grows increasingly complex at this stage as women at higher levels of STEM education or careers demonstrated cognitive dissonance regarding their experience of having gender-STEM stereotypes and facing barriers related to sexism, which encompassed denying they experienced these explicitly, but showing examples of internalised STEM-agentic or STEM-masculine biases, alongside overt examples of how women must try harder and sacrifice more to progress in STEM.

Overt denial of these stereotypes might protect their self-efficacy in STEM (e.g. Miller & Kaiser, 2001; Kaiser & Miller, 2001; 2003), showing that they are strong enough to overcome biases which might affect 'other women' but not them because they were 'special women'. Based on the findings, UK and Chinese women began to show more cultural differences at this stage. For instance, it was in the upper educational stages (postgraduate study) and into early career development that the challenges for women in the UK came from the top; i.e. they reached a "glass ceiling" in their careers because of men's privileged positions in science. In contrast, Chinese women were still strongly impacted by their families at this stage, and they struggled to establish a balance between family planning and their careers. These factors played a part in the women constructing their unique STEM-identities and also their gendered identities, but these did not always overlap, and they became increasingly in conflict as women

[18] Higher education is usually required for women working in academic STEM fields.

progressed through their STEM pathways, with the Chinese women showing the greatest identity-conflict here. Social identity theory holds that people strive to maintain a positive social identity (Tajfel, 1982). Thus, positive gender stereotypes are easily integrated with the self-concept and promote positive discrimination. However, women endorsed negative stereotype as positive stereotype might because treated these negative as ‘group descriptive’ rather than individual treat (Oswald & Lindstedt, 2006). When Chinese women in the Chinese gender group, they would confront their STEM-identity and disconnect (ignore) with the gender identity to avoid the negative gender stereotypes or it’s just for ‘group descriptive’, not their individual concerns; or they identify themselves as pioneer in the front of Chinese gender group, outstanding for breaking the old chain of gender identity. As such, Chinese women distinguished their STEM-identity with their gender identity, which associated with negative stereotypes in wider society, that they could achieve STEM-identity (STEM compatibility), which will discuss more in section Enhanced STEM-identity.

8.2.5 Overcoming Barriers: Pathway Facilitators

When considering STEM pathways holistically, four factors emerged as facilitators of these transitions, enabling women to move on from studying STEM to advanced research and working in STEM fields: 1) sustained interest and ability in STEM; 2) positive social support; 3) STEM identity; and 4) Cognitive dissonance. These factors will be discussed in the following sections.

8.2.5.1 Facilitator: Sustained interest and ability in STEM

In the questionnaire of Quantitative Phase One, there was an open question asked at the end regarding the participants’ maths scores[19]. Of the participants who answered this question, over 96% of the women studying in STEM fields from both countries achieved higher maths scores (>90 out of 100) at the end of high school/entrance examination for college. This relationship

[19] Due to incomplete responses, these results were not reported in the quantitative chapter.

between higher maths scores and women studying in STEM fields encouraged me to explore this aspect further in Qualitative Phase Two.

Qualitative findings showed that an interest in maths was highly related to women becoming involved in STEM fields. Firstly, most participants had a maths or science interest at a young age. In other words, they were driven by their own interests in maths or science subjects. Secondly, they also learnt maths effortlessly and got higher scores, which set them on the STEM path. For instance, better maths performances enhanced their belief in their maths ability and improved their sense of maths self-efficacy (Steele & Aronson, 1995, 2005). Participants further developed an interest in STEM fields when they began studying STEM subjects. Aside from their own STEM-related interests and skills, participants' career preferences were also essential at this stage. That is, they tended to choose STEM subjects that could be applied to real life and people so that they would be able to get an applied job in the future (e.g. healthcare). To some extent, their career preferences can also be linked to the influence of gender roles during their gender socialisation. For example, women perform more caring jobs in Chinese and UK society (e.g. Eagly & Mladinic, 1989; Li, 2002), which indicates a form of job segregation and also stereotypes for women (i.e. women tend to be carers). Thus, it can be said that biological and social-cultural impacts can lead women to do more caring jobs (Wang, Ye & Degol, 2017).

8.2.5.2 Facilitator: Social support of parents, teachers, role models & mentors

An interest in engaging with STEM fields does not only come from the women themselves, but also from interaction with their social environments (e.g. parents and teachers). For example, most of the British participants had parents or relatives who worked or held degrees in STEM fields. In this instance, these family members can serve as women's career role models and offer them support based on their own experiences of STEM careers, especially when there was a conflict with social gender norms. However, with the Chinese participants, the situation could be the opposite, as their parents had experienced difficulties or witnessed women having difficulties in STEM fields. In this instance, Chinese family members tended to persuade women to leave STEM fields or choose a non-STEM career.

Studies such as Eccles (2009) suggests that parents' education level and economic status could also affect their children's performances, especially parents with high socio-economic status (SES). Parents can offer their children insights and guidance if they have been through a similar higher educational system. This could consist of advice about how to communicate with teachers, how to attend classes to get higher scores in maths, etc. (Useem, 1992; Catsambis, 2005). Interestingly, if we take Chinese family's economic status into account, quantitative results show no clear correlation between parents' careers or education specialities and the subjects their children choose (see Study 1). However, focus groups and interviews revealed that quite a few participants had parents or grandparents working in STEM fields, which indicates better family economic environment (i.e. STEM fields are relatively higher paid job in China, participants being able to afford studying abroad is another indicator economic status).

There is also a unique historical influence that shapes the role that Chinese parents play in impacting women in STEM. The influence of traditional Chinese culture, in which women are associated with certain gender-roles to fit Chinese women's gender-consistent identity, is still strong. Since the one-child policy was still in effect for the Chinese cohort interviewed - from 1980 to 2016 (Feng, Gu and Cai, 2016) - a girl may be the only child for a family. As discussed in the introduction, this quickly shifted the story of patriarchy traditionally favouring sons, and in fact even reversed it. Usually, if a boy and a girl are born in the same family, they would historically have been treated differently in a Chinese family, as they tended to treat the boy as promising and the next successor carrying the family name. Due to the one-child policy leaving their families with no choice but to value them as daughters and heirs, what I learned from the Chinese focus groups and interviews is that some parents did not perhaps 'treat them as girls' and thus invested time, money, resources, and future hopes onto these girls for the first time.

This conflict between Chinese traditions and the social reality parents face with having only daughters has several impacts on Chinese women studying and working in STEM fields. First, Chinese parents may have raised their only child/daughter with contradictions around gendered identity – e.g. valuing masculine/agentic traits and studying STEM subjects more highly for career goal purposes. This may lead to confused gender identity associations with STEM careers for Chinese women, which might explain why we found implicit and explicit gender-STEM stereotypes on Chinese women studying in STEM fields and STEM incompatibility identity among Chinese women studying and working in STEM (Study1). However, regardless of the sex of one's child, Chinese families view marriage as a way to support the family structure, which partially explains why women working in STEM, who are not married, are often under strong pressure from their family to marry.

Overall, the UK cohort revealed less pressure from their parents and family to achieve not only STEM career goals but also familial role fulfilment. In contrast, the Chinese cohort had greater impact from prior family generations (even grandparents) due to historical (e.g. Confucianism) and policy (e.g. One-child policy) trends. Additionally, the UK and China also had different paths on the development of feminism (see Chapter 2). Their differences in whether they were bottom-up grassroots or top-down led (Jolly & Huibo, 2018), as well as the longer time period with the Western "bottom-up" movements in the UK (Karl, 2012) might have led to broader acceptance of women more gradually taking on traits and careers associated with historically traditional male gender role at the individual level. While the shorter time and "top-down" policy push for Chinese feminist movements might contextualise the stronger cultural impact remaining with the Chinese elder generation, and the likely uncompleted emancipation at women's individual experienced level (Thornham & Pengpeng, 2010).

8.2.5.3 Facilitator: Enhanced STEM identity

This factor is considered key to mitigating the adverse impacts of gender-STEM stereotypes. As social identity theory (Abrams & Hogg, 1988; Turner, Brown & Tajfel, 1979; Roccas & Brewer, 2002) argues, social identities develop based on group affiliation (e.g. careers, socio-economic status). Eccles (2007) also suggests that in STEM fields, the incompatibility between being women and being in STEM fields leads to attrition. Moreover, Settles (2009) found that women scientists with identity incompatibility tend to have lower performances and higher depressive symptoms. Therefore, it can be said that one way to retain women in STEM fields is to acquire STEM-stereotype-consistent (rather than gender-stereotype-consistent) identity -

i.e. a compatibility between one's STEM-identity. and one's interpretation of an 'atypical woman'. Overall, results showed that participants' STEM-identity was very closely tied to a highly gendered identity, often showing gender-stereotype reactance rather than consistent, but still they appeared highly affected by gender stereotypes about women.

Thus, STEM-identity is not obvious at first glance. However, when examining in what ways women in STEM fields are so "different" (i.e. less feminine) from other women, it is possible to find ways of achieving in STEM fields. These differences are the results of gender-STEM stereotypes or the distancing of a female identity in order to pursue careers in STEM fields. Lane, Goh, and Driver-Linn (2012) suggest that the relationship between gender identity and gender-science stereotypes is bi-directional. That is, women who strongly gender-identify tend to view themselves as less related to STEM fields and are easily affected by gender-science stereotypes; whereas women studying in STEM fields who weakly gender-identify tend to be less affected by the gender-science stereotypes. During their gender socialisation, women in STEM fields also pick up gender-science stereotypes and these should be less gender-identified and more STEM-identified. Thus, the key to retaining women in STEM fields may be for women to develop a STEM-identity over time and acquire and enhance the compatibility between STEM and gender.

Besides group affiliation, STEM-identity can also include valuing common personalities traits that were agentic. Overall, we found some common female characteristics from both nations. For example, participants tended to say they worked harder, have more persistence, and do not easily give up compared to male peers. Consistent with previous research (e.g. Zhang, 2014), some participants also expressed having outgoing personalities (e.g. networking, social skills). Recent research further notes developing supportive networking (e.g. connecting with seniors) as a potential strategy to overcome barriers for ECRs (Lido, etc., 2022).

8.2.5.4 Facilitator: Contradictory narratives- how cognitive dissonance may sustain women in STEM longer

The findings regarding cognitive dissonance among participants are well-supported by other studies. For instance, the recent VisNET collaborative study on early female researchers in academic engineering and the physical sciences found 'no gender inequality conflicting with later examples of gender discrimination' (Cebula, et al., 2019). Moreover, participants' contradictory narratives are consistent with the Quantitative Phase One results showing women in STEM fields had lower gender-STEM stereotypes than other women.

Nevertheless, it is worth noting that participants' contradictory narratives were not so much explained by them denying the existence of discrimination, as the Chinese cohort felt they had faced national stereotypes and discrimination. Rather, they felt that they were 'immune' to gender stereotypes and sexism as they were either 'strong' or 'not typical/special women'. Indeed, previous research has found that people can sometimes deny that they are experiencing discrimination and prejudice even when they are (Crosby, 1984; Hodson & Esses, 2002). It may be a form of escape from reality which provides comfort (Lerner, 1980) or a coping mechanism to cope in situations of structural inequalities and institutional discrimination. Another study argues that people sometimes deny the reality, for instance because of stress, which then leads to lower self-esteem (Major, Kaiser, & McCoy, 2003). The lower self-esteem needs can be compensated for with a higher level of self-confidence on a dimension that is not threatened, or derogated, such that stigmatised characteristics can be changed or re-valued. This might explain the high value participants placed on agentic and stereotype-consistent 'think-STEM, think-male' associations. In other words, people generally do not like to be judged by others (Kaiser & Miller, 2001; 2003), and if being perceived as traditionally feminine or even communal is threatening to one's identity and esteem, it may be that these participants have implicitly distanced themselves from communal trait identification and communal (teamwork) narratives. While it is hard to define this as either 'good' or 'bad' for women in STEM fields, I consider it a facilitator along the pathway because they may help women to 'filter' out the 'bad' influence of gender-STEM stereotypes on women in STEM fields.

8.2.6 Processing Barriers: Pathway Overlook

This section will discuss the main obstacles for women studying or working at the higher level of STEM fields.

8.2.6.1 Barrier: Lack of same-sex role models and mentors 'at the top'

Early research on girls being exposed to female scientists suggested that this exposure improved girls' maths performances (e.g. Carrell & West, 2010). For young girls, role models (teachers and parents) serve as mentors guiding them and giving them support. However, role models take on different forms during different periods of life. In higher education or careers, role models are likely to be female professionals or female leaders in their fields – which are the very areas in which women are underrepresented. Among the limited number of role models seen at the top of the field, if women see other women successfully working in STEM fields, they can develop a greater self-concept in STEM careers and enhance their STEM-identity, which can motivate them to engage in STEM and pursue careers in this field (Stout, Dasgupta, Hunsinger, & McManus, 2011). For women already in STEM fields, exposure to female role models can protect them (Marx & Roman, 2002). Thus, providing female role models might be the key to retaining women in STEM fields (Drury, Siy, & Cheryan, 2011). On the other hand, when women learn about the strengths and weaknesses of these role models and how hard it is for their role models to succeed in STEM fields, they may wish to avoid such hardships (Smith, et al., 2013). This might constitute another main reason why women leave the field when they have degrees in STEM.

Overall, participants in this sample reported few role models, and those that they did mention were often family members. Most participants further noted that they had few female role models or even same-gender colleagues that they looked up to in their chosen careers. This made many of them question whether they should even pursue a career in STEM fields. Thus, providing women with mentorship, for instance senior professional connecting (Lido et al., 2022), might help participants develop a role-model type relationship.

8.2.6.2 Barrier: Patriarchal cultural impacts

As with the conception of role modelling above, the impact of a patriarchal society and embedded masculine-STEM stereotypes emerged as an issue for all participants; especially in the form of 'men as gate-keepers' and the dwindling numbers of women reaching the highest levels of STEM (Lido et al., 2022). Regardless of their national origin, it was clear that participants developed implicit and explicit stereotypes, which many had reacted against (unconsciously or overtly) in their pursuit of STEM. However, cultural impacts particularly emerged as a major point for Chinese women regarding their beliefs about women in STEM, as well as in gender-roles which were at times in direct conflict to these STEM career ambitions. This might be because of cultural differences of developing in a more traditional, patriarchal society with a strong influence of Confucianism.

To be specific, in Quantitative Phase One, Chinese women held overtly greater gender-STEM stereotypes; in addition, the implicit differences appeared only between Chinese women studying in STEM and non-STEM. Likewise, Qualitative Phase Two results revealed the very real internalised gender stereotypes and gender role adherence among Chinese women. I have considered many times what the impact of traditional Chinese culture is on Chinese women, such as myself and my participants. It has such a wide range of interpretations and definitions, as can be seen in the literature and in the contexts explored in this thesis. Here, the origin relates to Chinese women, during their gender socialisation, growing up in a Chinese cultural environment that is greatly affected by Confucian thoughts. The impacts of Confucianism on the roles of Chinese women are deeply connected to their families and their families' expectation that they, as women, fit into traditional Chinese women gender roles. These thoughts are still greatly affected by patriarchal ideas (e.g. Deng, 2016). Overall, Confucianism might be considered the main reason for the unique characteristics of the Chinese and explain why they have such deep bonding with and care for their families, as well as many other positive personality traits. The close connection with one's family can also represent a chain for women, forcing them to remain close to their families so as to be 'good wives', 'good mothers', and 'good daughters' (Liu, 2016). This conflicting struggle is described in the narratives above, but truly felt in the qualitative focus groups and interviews of the Chinese women who were all mentally negotiating the lines between their career ambitions and desires, as well as social pressures, for marriage and children by a certain age.

I also considered the relationship between Confucianism and collectivism, as they both emphasise the roles of Chinese women in the family (Tu, 1994; Ames, 2011), not as individuals, but as parts of families, and their responsibilities as women. These perspectives of Chinese identity suggest how culture impacts Chinese women in STEM fields, adding to their STEM-identity. Chinese women's STEM-identity appears to be more affected by their families from a cultural impact, which in line with some western research indicates that culture is an essential factor impacting women's underrepresentation in STEM fields (e.g. Ramirez & Wotipka, 2001; Jordan & Yeomans, 2003; Penner, 2008; Ceici, Williams, & Barnett, 2009).

8.2.6.3 Barrier or Benefit? Chinese women reproducing both collectivism and individualism

As discussed above, traditional Chinese gender roles, passed on through their family, still have strong impact on Chinese women (e.g. Tu, 1994). Quantitative Phase One findings showed that Chinese participants had higher gender-STEM stereotyped attitudes of women in STEM than their UK peers – i.e. they perceived STEM careers as associated with male domains. However, Qualitative Phase Two findings suggest that Chinese women studying in STEM fields may have developed certain aspects of an agentic STEM-identity to defend themselves against such a process of traditional 'gendering'.

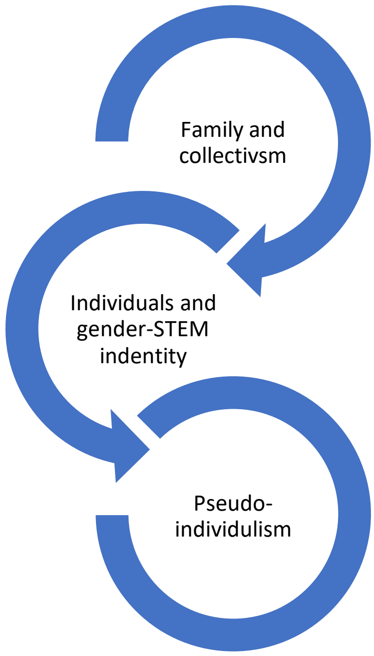
Although Chinese participants stated that STEM fields could be for everyone, they also expressed narrow conceptions of what a 'STEM person' or arts and humanities person might 'be like' or 'dress like'. Powell, Dainty and Bagilhole (2012) offer a potential explanation for these apparently contradictory statements, based on their study involving women in engineering and technology in the UK. That is, the contradictory view derived from the need to fit into an individualist framework of a natural self and a gendered self at the same time. To further explain this contradiction in the Chinese context, consider that women's own gender stereotypic beliefs are the products of their environments. It can therefore be argued that they may have built up a strong STEM-identity, alongside gender-stereotype reactance at the individual, trait-based level. However, as Chinese women have strong connections with their families, the process of gender maturity involves a process of fitting into one's family (or social) expectations, which affect their gender roles even when they have grown up (Ames, 2011). In other words, the gender-STEM stereotypes received from their families substantially impact Chinese women within a Chinese collectivist context.

Therefore, successful Chinese women in STEM fields might have succeeded as a result of several possible conditions based on interactions between their development of gender-STEM identity and the impact of gender-STEM stereotypes received from their families. First, it is possible that their families had a weaker impact on them, so they could develop their own interests and receive support from their families. That is, their parents provided a more liberated nurturing environment and had lower traditional expectations of them. This might result in the women more easily receiving their parents' full support and being less controlled by their parents, helping them to develop their self-STEM identity and related interests. Second, it is also possible that they had a strong gender-STEM identity and self-motivation and were not greatly affected by their families. That is, even if they were pressured otherwise, they were driven by their own interests and motivations, which were strong enough to counter the impact of gender-STEM stereotypes. Finally, it is also plausible that there was harmony between the individuals' identities and their families' impacts. That is, the relationship between the two might become balanced over time, with neither becoming too strong nor too weak.

Considering these three possibilities from a cultural orientation perspective, Triandis (1990, 1993) suggested that collectivism and individualism are not bipolar dimensions as most cultures are a mix of both, with different dimensions and features being more prominent at different points in time. Put briefly, individuals can adopt both individualistic and collectivistic values - feeling both a sense of duty to their family and societal norms while also valuing their personal goals and independence. Regardless of the situation Chinese participants found themselves, it can be argued that their STEM identities may have developed much more strongly than those of other Chinese women (women who are not successful in STEM fields) so that they could overcome the impacts of their families (and society) within a collectivist context. Put differently, the development of their STEM identity can be said to be similar to the women in the UK who are in an individualist context, where there is a focus on the development of oneself. However, for Chinese women, this is not really a form of individualism as it is in Western culture, but still strongly connected with Chinese culture. In other words, the development of one’s STEM identity is a process, which progresses from a conflict into an interaction, and ending with a balanced harmony, which results in Chinese women enjoying successful STEM educations and careers. It can be argued that successful women are able to do this or are “lucky” - i.e. they can benefit from this balance by developing their STEM identity to achieve successful STEM educations and careers within the Chinese cultural context. This is a development can be defined as pseudo-individualism within Chinese culture, as occupational differentiation is highly related with individualism, because women found the suitable job for themselves to interact with society, which is the essential direction for individualism (Triandis, 1993), rather than a compromise under collectivism.

A historical consideration of the changing role of collectivism in Chinese society can help to further explain the pseudo-individualism that is proposed to have been adopted by Chinese women who are successful in STEM careers. Collectivism was primarily promoted among the Chinese population before 1978. Following the Open Door Policy implemented in 1978 in China, massive transformations took place in people’s daily lives and interactions in different social environments. For instance, they led to the forming of new meanings of Chinese collectivism when applied to Chinese women – i.e. Chinese feminism based on traditional culture and collectivism developed in new directions for the women growing up during this period. Xu (2005) suggested that with the development of society, the cultural patterns of individualism and collectivism began to merge situationally. It can be argued that this could have inspired Chinese women to develop a form of ***pseudo-individualism*** (*Figure 15-8.2*) to match economic and environmental development - i.e. when meeting one’s basic needs is no longer the main issue for individuals, they tend to develop themselves based on their own interests.

Figure 15-8.2: Pseudo-individualism: The Harmony Balance of Individualism under Collectivism



8.3 Limitations and Strengths

There were a number of limitations which will now be addressed, and consisted of quantitative sample sizes, comparison of two nations and the Chinese students and researcher in the UK, although there are likely more limitations to be considered. Following this, strengths will be addressed accordingly.

8.3.1 Limitations

Although the sample size for this research was sufficiently large to meet the standards for statistical analyses, unequal cell sizes are a limitation of the study. The reasons for unequal numbers of women in each national and STEM subject group are complicated. Firstly, it is not easy to recruit women in STEM fields, particularly in core hard science subjects (e.g. physics) where women are less represented. However, a strong point of the study is that I was able to find Chinese women with a higher level of education (despite their underrepresentation). Future studies would benefit from enlarging the number of participants in each national and STEM subject group to test main effect differences between nationalities. Nevertheless, I achieved the primary research aim of offering a broad understanding of Chinese and British women's underrepresentation in STEM fields, especially at higher levels of education and careers.

It is also worth noting that this is not a comparison of Western and Eastern cultures as there is a plethora of other national contexts to consider. However, one of the motivations for this thesis is the lack of research on this specific topic only based on UK samples or a comparison between the UK and China PhD students, which is what inspired this thesis. Although this research adds to the literature in the Chinese and UK contexts, it should be acknowledged that the UK and Chinese samples fails to take into account the diversity within British and Chinese culture. My Chinese sample was limited to women who are studying abroad in the UK, which is a very special subset of Chinese women for various reasons. For example, they can afford to go abroad, they had the confidence to go abroad, and they were introduced to different cultural norms while in the UK. Nevertheless, this was a convenient sample to access that still provides important insights as they are outstanding women successful in STEM fields in a different cultural context. Moreover, throughout the study, comparisons were made with great caution based on the data. For future research, I would like to replicate this work with a more diverse sample across the different regions in China and the UK, as well as exploring more diverse demographic characteristics, such as Chinese women from rural areas of deprivation, those who are LGBT+ and from other minority (religious groups).

8.3.2 Strengths

A novel contribution and strength was the design and methodology used in this thesis, and the cross-cultural contexts that it incorporates. Firstly, it combined implicit and explicit methods to understand gender-STEM stereotypes in two nations. The quantitative phase was also followed by a qualitative phase to unpack in greater detail why women are underrepresented in STEM, as well as why they remain in STEM fields, thus presenting a more holistic picture of women's pathways within STEM fields – including the main facilitators and obstacles from a cross-cultural perspective.

The next strength of this thesis was its novel approach to reviewing the pathway of women studying and working in STEM fields. Cultural context was also richly explored in this thesis as it examined UK and Chinese women at higher levels of STEM fields and Chinese women with study and work experiences in both countries. These findings expand our understanding of the socio-environmental impacts on these women, the main challenges and facilitators they encountered and the cultural differences and similarities along their pathways. This allows a deeper understanding of the compatibility identity between gender and STEM and how this STEM-identity allows women to defend themselves against the negative impacts of gender-STEM stereotypes. While it is not possible to eliminate gender stereotypes entirely, as they have their roots deeply immersed within society and culture, the present research offers various routes by which we can prevent and decrease the effects of gender stereotypes by using multiple methods, such as by changing the visibility, the basic conditions under which women work and are paid, and by better supporting women's networks and mentorship. When studying measures taken to address gender stereotyping, the majority of researchers have focused on girls' development of STEM interests to predict their future career choices (e.g., Wang & Degol, 2013). However, another strength of this thesis is that it extends the pathway to look at higher educational transitions into early careers, and potentially further for a long view of progression within STEM fields.

In brief, this research contributes to the literature by examining differences between cohorts of women, studying different STEM subjects from two national backgrounds. It offers new findings in a non-western context, to consider gender-STEM inequalities from the Chinese perspective, and combines implicit, explicit, quantitative and qualitative research looking at women's journey into and out of higher education.

8.4 Implications, Suggestions and Future Research Directions

8.4.1 Practical Implications

Based on the findings related to the four main stages along a successful STEM pathway, this thesis offers several practical implications and suggestions for education and government policies. First, since it is not easy for women to recognise the gender-STEM stereotypes that affect them, we should offer girls positive support (e.g. STEM awards with a gender balance). In addition, girls should also receive encouragement when they enrol in science-related courses, especially in China. One way to do this would be to incorporate training on gender-biased attitudes when teachers receive training in pedagogy. Another way is to present positive female role models in different careers within STEM. For instance, female students who already have interests in STEM fields in particular should be encouraged to continue by being shown real female experiences so that they can make informed career decisions.

When it comes to supporting women in their career decisions, information relating to STEM careers need to be disseminated to Chinese high school students when they choose subjects for the CCEE exam. While in the UK context, British women could be offered greater flexibility in choosing their majors.

When it comes to supporting women's retention in STEM fields, findings indicate the need to improve communication among existing female communities and female professors in different STEM fields. For instance, results showed that British women in STEM fields have few female role models to as women are still underrepresented in the hard sciences at higher career levels. In other words, women need real-life examples to support them and to feel a sense of belonging to STEM. This could be facilitated by the use of social media – such as Twitter, which is currently used in academia to share information about new journal papers, conferences, and professional experiences – to promote the exposure and career profiles of successful female role models in STEM. Given the socio-cultural pressures Chinese women in STEM face (e.g. marriage anxiety, familial responsibilities), developing Chinese women's support groups/communities in STEM is also recommended. By providing more exposure to successful female scientists with family roles (i.e. mothers, wives), women can be shown to be capable of performing both professional and family roles, thereby decreasing the anxiety felt by women who feel they have to choose between being a mother or being good at their career. The Chinese government could also develop equality policies to allow greater flexibility for women in the workplace.

8.4.2 Future Research Directions

Based on the findings of this thesis, future research could consider how additional factors such as family and socio-economic status interact with gender. For instance, Chinese women's presence in higher education might be strongly related to their family status and less related to gender-STEM stereotypes – i.e. all of the participants in this study were born under the "one child" policy, in line with which a family dedicates all their resources to the only child no matter what gender the child is. The Chinese cohort might also come from higher socio-economic family backgrounds, as is usually the case for Chinese international students, or their parents might also have an academic background. The Chinese participants I found also had no children. Thus, when we discussed family-career issues, the women could only assume what might happen in their futures. Exploring variations in the women's family status (e.g. married with/without children) is another avenue for future research. Moreover, since the Chinese cohort were all studying/working in STEM in the UK, future work should examine whether the findings replicate for Chinese women studying/working in STEM in China. Finally, considering the COVID-19 pandemic, which brought about changes in how we work, collaborate, and rely on social networks, future research could also explore how networks in STEM fields (after the pandemic) impact women in STEM fields (e.g. did they reduce gender-

STEM stereotyping for women in STEM as they may have had less gender-identity recognised in online networks during the pandemic).

8.5 Summary of Conclusions

This thesis expands the existing knowledge base around women's underrepresentation in STEM fields in the UK and China. Overall, quantitative results indicate national differences in explicit gender-STEM stereotypes, such that gender-stereotyped attitudes were found to be greater among Chinese women than British women. However, regardless of nationality, women studying in STEM fields held weaker gender-STEM attitudes than those in non-STEM fields. Accordingly, qualitative results shed light on how these gender stereotypes were developed and experienced among women studying and working in STEM in the UK.

Collectively, triangulated findings suggest a pathway consisting of four stages for women studying or working in STEM fields: starting, impact, entry, and maintenance. In the early stages, girls are primarily impacted by their parents and teachers and influenced by gender stereotypic attitudes formed during their gender socialisation. When girls receive encouragement from their environment, they tend to perform better in maths or science. National differences become more prominent in the latter stages as cultural issues affect women from two different directions. For women in the UK, obstacles stem from the 'glass ceilings' of male privilege in the hard sciences. In contrast, Chinese women faced challenges from the ground up as they face barriers of the 'sticky floor' mainly from their families and traditional Chinese society regarding familial gender-role expectations conflicting with their developed agentic gender-STEM identities. Thus, two key obstacles for women in STEM are 1) the lack of female role models (e.g. professors) at the top career levels, which discourages women from entering into STEM fields; 2) impact of culture, particularly among Chinese women, which leads them to feel insecure within STEM fields. Accordingly, key facilitators along the pathway for women pursuing STEM include 1) women's sustained interest and ability in maths or science; 2) positive social support from parents, teachers, role models and mentors; 3) women developing enhanced STEM-identity to filter out the negative environmental impact of being women in STEM; and 4) women's denial of contradictory narratives (cognitive dissonance) regarding implicit gender-STEM stereotypes serving as a form of self-defence.

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APENDIX FOR PHASE ONE

Appendix 1: Implicit Association Test (IAT) Gender-Science instructions and settings

Starting

Instructions (Starting)

Hello!

There are seven parts. The instructions change for each part.
Please pay attention!

Please press SPACE when you are ready to get started!

(intro1)
Humanities Science

You will see a word in the screen center. Please match it into two different categories.
Please put a left finger on the F key for items that belong to the category Humanities**.**
Please put a right finger on the J key for items that belong to the category Science**.**
Items will appear one at a time. Please react as fast and accurately as you can!

Please press SPACE when you are ready to go!

Section1
Humanities Science

Sti
Sti: words from Science Group 1 time Randomly.

(intro2)

Female Male

You will see a word in the screen center. Please match it into two different categories.
Please put a left finger on the F key for items that belong to the category Female**.**
Please put a right finger on the J key for items that belong to the category Male**.**
Items will appear one at a time.

Please press SPACE when you are ready to go!

Section2
Female Male
Sti
Sti: words from Gender Group 1 time Randomly.
(intro3)
Female Male
Humanities Science

Use the F key for Humanities **and for** Female**.**
Use the J key for Science **and for** Male**.**
Each item belongs to only one category.
Go as fast as you can while being accurate.

Appendix 2: Gender / Discipline Word Pilot Questionnaire

Gender Word Pilot Questionnaire (English Version)

To what extent would you rate the following words as masculine or feminine?

Please tick "✓" in the box below "1" refers to very **fe**minine, "**4**" refers to very **masculine . Just select the first thought that comes to mind. Thanks very much!**

Feminine/Masculine Words	→			
	Very Feminine 1	Slightly Feminine 2	Slightly Masculine 3	Very Masculine 4
Girl				
Female				
Aunt				
Daughter				
Wife				
Woman				
Mother				
Grandma **Man**				
Boy				
Father				
Male				
Grandpa				
Husband				
Son				
Uncle				

Gender Word Pilot Questionnaire (Chinese Version)

请给下列词语在男性化和女性化程度分级（“1”代表极度女性化，“4”代表极度男性化），并在你认为合适的数字下面画勾（“✓”）。谢谢您！

女性化/男性化程度 / 词语	极度女性化 (1)	轻微女性化 (2)	轻微男性化 (3)	极度男性化 (4)
女孩				
女性				
阿姨				
女儿				
妻子				
妇女				
母亲				
奶奶				
男人				
男孩				
爸爸				
男性				
爷爷				
丈夫 儿子				
叔叔				

Discipline Word Pilot Questionnaire (English Version)

Tick about the following subjects of study in Science and Liberal Arts.
Please rate（"✓"） in the box below think about whether they are associated more with Females or Males in your country? Just select the first whether them are perceived by your culture (*not to you personally*) as more Feminine or Masculine（"1" refers to very Feminine，"4" refers to very Masculine）.

We understand that you might not want to make a forced choice, you may not personally feel this way, but please answer based on the first instinct as to typical people think in your country might think

Feminine/Masculine → Subject	Very Feminine （1）	Slightly Feminine （2）	Slightly Masculine （3）	Very Masculine （4）
History				
Arts				
Humanities				
English				
Philosophy				
Music				
Literature				
Astronomy				
Math				
Chemistry				
Physics				
Biology				
Geology				
Engineering				
Accounting Computer Science				
Medicine				
Psychology				
Sociology				

Discipline Word Pilot Questionnaire (Chinese Version)

请给下列学科归属于理科和文科程度分级（“1”代表极度文科学科，“4”代表极度理科学科），并在你认为合适的数字下面画勾（“✓”）。谢谢您！

文科/理科 程度 学科	极度文科 （ 1）	轻微文科 （ 2）	轻微理科 （ 3）	极度理科 （ 4）
天文学				
数学				
化学				
物理				
生物				
地理 工程学				
历史 艺术				
人类学				
英语 哲学				
音乐				
文学				

Appendix 3: Questionnaire

Questionnaire used after IAT

Hello! Please Tick, Circle or Write your answers. Just follow your first instinct! This questionnaire is anonymous and all data will be strictly confidential. You may withdraw at any time.

Nationality: (British/Scottish/Irish) UK ☐ Chinese ☐ Others ☐

First Language: English ☐ Chinese ☐

Gender: Female ☐ Male ☐ Other ☐

Ethnicity: White ☐ Asian ☐ Black ☐ Multiethnic ☐
Other: ______________________________

Age: _____________

Main Subject of Study: ______________________________

Level: Undergraduate (Bachelor Degree)
1st year ☐ 2nd year ☐ 3rd ☐ 4th ☐
Postgraduate (Master Degree) ☐
Postgraduate Research (PhD) ☐
Other: ______________________________

Have you done an IAT before? ☐ Yes | ☐

Please rate your attitude towards STEM subjects (Science, Technology, Engineering and Mathematics).

☐ *1* ☐ *2* ☐ *3* ☐ *4* ☐ *5*

Strongly dislike Strongly li

*Please rate your attitude towards **Arts &Humanities** subjects.*

☐ *1* ☐ *2* ☐ *3* ☐ *4* ☐ *5*

Strongly dislike Strongly like

How strongly do your associate the following subjects with males and females?
1=strongly male, 2= moderately male, 3= slightly male,

Please use a feeling thermometer to rate the degree of warmth you feel toward these types of women on a scale from 0 (very cold/ unfavorable) to 100 (very warm/favourable). Please give your first instinct, even if you are not familiar with the job (give a number please).

Female	0°F(-18°C) → 100°F(36°C)
Anthropologist	
Artists	
Astronomers	
Biochemists	
Biologists	
Community Workers	
Engineers	
English Experts	
Geologist	
Historians	
Scientists	
Mathematicians	
Medical Doctors	
Musicians	
Philosophers	
Physicists	

DID YOUR PARENTS (OR GUARDIANS) EVER STUDY STEM SUBJECTS?
☐ YES | ☐ NO

If so, which level and what qualification have they achieved? Please write down below.

HAVE ANY OF YOUR PARENTS (OR GUARDIANS) EVER WORKED IN STEM OCCUPATIONS? ☐ YES | ☐ NO
IF YES, PLEASE STATE THEIR RELATIONSHIP TO YOU: ____________

____

What is your ideal occupation?

WHAT DO YOU REALISTICALLY THINK YOUR FIRST PAID EMPLOYMENT WILL BE UPON GRADUATION? ______________________

Appendix 4: Protocol and Themes

Chat question (when waiting, make sure what's their specific majors): Do you intend to work in STEM after you finish your PhD? Which occupation?
General instructions:
(everyone has been seated
around the table: water in the cup and some sweets, chat with people that make them talk more later)
Hello, Everyone! My name is Jianshu Liu. Thanks for joining this focus group.
I have several questions about women studying in STEM subjects (STEM stands for science, technology, engineering and mathematics). The purpose is to get your own experiences and perceptions about female in STEM. There are no right or wrong or desirable or undesirable answers. You could answer the questions according your own experience, either reflect on others' opinions. It is a free and open to discuss. I would like you to feel comfortable with saying what you really think and how you really feel.

Recorder instructions
If it is okay with you I will be recording our discussion. The purpose of this is so that I can get all the details but at the same time be able to carry on an attentive discussion with you. My college will help me record. All your comments and discussions remain confidential. I will use these comments and discussions in my thesis without any reference to individuals. I would like to add all your names to my Acknowledge to appreciate my deep thanks to you with your permissions.

Information/Consent form instructions
Before we get started, please take a few minutes to read the information form (send before they come) and signed the consent form. It will take around 1 hour or so.
(send out the Information Form and Consent Form, begin to record)

Questions:

(try to let everyone talk not too much or too little, use eye contact or gestures. Try to give them neutral but positive reflections to encourage them to talk.)
From society (stereotype and culture)/ From others' impact (parents and role model)/From individual(motivation/attitudes)

1. When did your interest in STEM first start?
   (if the answer is child: When did you start your interest in STEM as a child? e.g. primary school, high school…to continue Q2)
   How was your performance on mathematic? (science subjects on general? physics, chemistry, biology) when you were in high school (before going into the university).

2. About key moment of STEM career: When was your crucial /key moment when you decided choose STEM as your future career?
   (timeline: before school, primary school, high school or university…)
   (might be a story here. Too long cut it and get to the point; or they won't expose too much, encourage them by telling my own story.)

About motivations /interests of STEM (could pop out when they discuss Q1 &2, if not ask then)

(in their own area, make it specific that might have difference between different subjects)

Appendix 5: Ethic Approval Letter

University of Glasgow

College of Social Sciences

02 August 2017

Dear Jianshu Liu

College of Social Sciences Research Ethics Committee

Project Title: Gender, Implicit Associations (IAT) and Women in STEM: A Cross-Cultural Comparison of Chinese and British Students
Application No: 400160248

The College Research Ethics Committee has reviewed your application and has agreed that there is no objection on ethical grounds to the proposed study. It is happy therefore to approve the project, subject to the following conditions:

- Start date of ethical approval: 03/08/2017
- Project end date: 02/06/2019
- Any outstanding permissions needed from third parties in order to recruit research participants or to access facilities or venues for research purposes must be obtained in writing and submitted to the CoSS Research Ethics Administrator before research commences. Permissions you must provide are shown in the *College Ethics Review Feedback* document that has been sent to you.
- The data should be held securely for a period of ten years after the completion of the research project, or for longer if specified by the research funder or sponsor, in accordance with the University's Code of Good Practice in Research:(http://www.gla.ac.uk/media/media_227599_en.pdf)
- The research should be carried out only on the sites, and/or with the groups and using the methods defined in the application.
- Any proposed changes in the protocol should be submitted for reassessment as an amendment to the original application. The *Request for Amendments to an Approved Application* form should be used:
  http://www.gla.ac.uk/colleges/socialsciences/students/ethics/forms/staffandpostgraduateresearchstudents/

Yours sincerely,

Appendix 6: Participant Information Sheet

University of Glasgow

College of Social Sciences

Dr Muir Houston
College Ethics Officer

Title of Project: **Gender, Implicit Associations (IAT) and Women in STEM: A Cross-Cultural Comparison of Chinese and British Students**

Researcher: **Jianshu Liu**
Supervisors: **Catherine Lido & Kara Makara Fuller**

You are being invited to take part in a research study. 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 to decide whether you want to take part. Please ask for clarification if there is anything that is not clear or if you would like more information.

Do I have to participate?
It is up to you to decide whether to take part. Even if you decide to take part you are free to withdraw from the study without giving a reason.

Why have I been chosen?
I am studying women's implicit gender-based science stereotype in a focus group among University students. For research purposes we are only recruiting women for this research activity.

Purpose of this study
This research is being carried out at the University of Glasgow as part of my doctoral research project. It aims to improve our understanding of Gender-Science Stereotypes among female students. The Gender-Science Stereotype you might have depend on numerous factors so we are using a variety of activities to better understand these. The anticipated risk is low, but in the unlikely case that you feel uncomfortable, you can withdraw at any time.

What you need to do?
This study will be carried out at one time within a computer lab on the University of Glasgow campus. In total the activity should not take more than 30 minutes and contains two parts:
1. Complete a computer-based test which assesses your response accuracy and speed to a number of questions.
2. Complete a short questionnaire after the computer task about your demographics and some brief questions related to your beliefs about women and STEM.

Confidentiality
All information that is collected about you during the research will be kept strictly confidential. Electronic data will be stored on a password protected computer. Any information you provide such as answers will only have a code number assigned so that you cannot be recognised from it. The findings will be reported in the student's PhD thesis as well as possibly at conferences or in academic journals. Personally, identifying data will be

Appendix 7: Consent Form

University of Glasgow

College of Social Sciences

Title of Project: Gender, Implicit Associations (IAT) and Women in STEM: A Cross-Cultural Comparison of Chinese and British Students
Name of Researcher: Jianshu Liu
Name of Supervisors: Catherine, Lido & Kara Makara Fuller

1.I confirm that I have read and understood the Participant Information Sheet for the above study and have had the opportunity to ask questions.

2.I understand that my participation is voluntary and that I am free to withdraw at any time, without giving any reason.

- ☐ All names and other material likely to identify individuals will be anonymised.
- ☐ The material will be treated as confidential and kept in secure storage at all times.
- ☐ The material will be destroyed once the project is complete.
- ☐ The material may be used in future publications, both print and online.
- ☐ I agree to waive my copyright to any data collected as part of this project.

3. I agree / do not agree to take part in the above study.

I agree to take part in this research study

I do not agree to take part in this research study

Name of Participant ………………………………
Signature …………………………
Date ………………………………

Name of Researcher …………………………………………………
Signature ………………………….

Date ……………………………………

Appendix 8: IAT Data Management

IAT Data Management in E-prime

Step One: Merge data into a large data file in E-DataAid (E-prime software) ready to compute later in R Studio.

1. Merge Chinese and English versions of E-prime data, respectively. Images and texts were used in the two different versions, because the columns' names showed differently when they were automatically exported.
2. Open the merged data file in E-DataAid and filter out the irrelevant data for computation. Blocks 1, 2 and 5 were practice blocks, and did not constitute real data. Only Blocks 3, 4, 6 and 7 were kept as they represented useful data. We did not design any form of feedback but asked the participants to correct their incorrect responses. E-prime does not offer feedback in terms of the accuracy rate of responses. In this case, we kept the correct response key (what the participants should have responded) and the response key (what the participants in fact responded) and exported them into Excel. Then, we used the formula "= (cell name1=cell name2,0,1)" to obtain the accuracy for each participant in each trail denoted by a number "0" or "1". "0" indicates that the two selected cells were the same, i.e. the response was correct. "1" indicated an incorrect response. Other selected items in E-DataAid were the participants' number, the stimulus for each trail, and block names.
3. Finally, the participants' numbers, block names, reaction times, accuracy and stimulus for each trail in Blocks 3,4, 6 and 7 were compiled in two (English and Chinese versions) Excel data files.

Step Two: Importing into R Studio to compute IAT D score

1. Import the data file into R studio. Two versions of the data files were used by the same computation and were only different when the data was imported.
2. Merge all reaction times and accuracy rates into one row. We obtained one row of reaction times, one row of accuracy rates, corresponding to each participant's number. The error rate was calculated for each participant. Subjects for whom more than 10% of trials had a latency of less than 300ms (no participants in this study) were deleted.
3. Filter out the extreme values of more than 3000ms and less than 300ms to eliminate "outliers". (No outliers were found).
4. Select all correct trails and the mean reaction time (RT) for each block and participant.

R Full Script for IAT-English Version

```
IAT.all<- read.csv("56-2.csv",header=TRUE,sep=",")
library(tidyverse)
RT <-
IAT.all$TextDisplay1.RT+IAT.all$TextDisplay3.RT+IAT.all$TextDisplay4.RT+IAT.all$Te
xtDisplay5.RT
Error<-
IAT.all$TextDisplay1.ACC+IAT.all$TextDisplay3.ACC+IAT.all$TextDisplay4.ACC+IAT.a
ll$TextDisplay5.ACC
IAT.all.useful<-select(IAT.all,Subject,Running)
IAT.all.useful<-cbind(IAT.all.useful,RT,Error)
IAT.all.useful<-rename(IAT.all.useful,c("Running"="Block"))
IAT.all.useful=filter(IAT.all.useful,Block=="EList3"|Block=="EList4"|Block=="EList6"|Blo
ck=="EList7")

write.csv(IAT.all.useful,"IAT.useful.56-2.csv")
er<-IAT.all.useful%>%
  group_by(Subject)%>%
  summarise(ER=(sum(Error==1)/length(Error))*100)
write_csv(er,"ER.All useful data.56-2.csv")
filterout=IAT.all.useful[IAT.all.useful$RT<300|IAT.all.useful$RT>3000,]
filterout$Error="0"

correctIAT.all.useful=filter(IAT.all.useful,Error!=1)
rt<-correctIAT.all.useful%>%
  group_by(Subject,Block)%>%
  summarise(meanRT=mean(RT))

errorIAT.all.useful=filter(IAT.all.useful,Error==1)
errors=merge(rt,errorIAT.all.useful,by=c("Subject","Block"))
errors$RT=errors$meanRT+600
errors=select(errors,-meanRT)
rt.overall=rbind(correctIAT.all.useful,errors)

complete.table.SPSS=rbind(rt.overall,filterout)

rt.mean<-rt.overall%>%
  group_by(Subject,Block)%>%
  summarise(meanRT=mean(RT))
sd.p<-rt.overall%>%
  group_by(Subject)%>%
  summarise(SD=sd(RT))
sd.p.block<-rt.overall%>%
  group_by(Subject,Block)%>%
  summarise(SD=sd(RT))

block3and6<-rt.overall%>%
  filter(Block=="EList3"|Block=="EList6")%>%
  group_by(Subject)%>%
```

R Full Script for IAT-Chinese Version

```
IAT.all<- read.csv("All Data for R.csv",header=TRUE,sep=",")
library(tidyverse)
RT <-
IAT.all$ImageDisplay1.RT+IAT.all$ImageDisplay2.RT+IAT.all$ImageDisplay3.RT+IAT.al
l$ImageDisplay4.RT+IAT.all$ImageDisplay5.RT
Error<-
IAT.all$ImageDisplay1.ACC+IAT.all$ImageDisplay2.ACC+IAT.all$ImageDisplay3.ACC+I
AT.all$ImageDisplay4.ACC+IAT.all$ImageDisplay5.ACC
IAT.all.useful<-select(IAT.all,Subject,Running)
IAT.all.useful<-cbind(IAT.all.useful,RT,Error)
IAT.all.useful<-rename(IAT.all.useful,c("Running"="Block"))
IAT.all.useful=filter(IAT.all.useful,Block=="EList3"|Block=="EList4"|Block=="EList6"|Blo
ck=="EList7")

write.csv(IAT.all.useful,"IAT.all.usefull.csv")
er<-IAT.all.useful%>%
  group_by(Subject)%>%
  summarise(ER=(sum(Error==1)/length(Error))*100)

filterout=IAT.all.useful[IAT.all.useful$RT<300|IAT.all.useful$RT>3000,]
filterout$Error="0"

correctIAT.all.useful=filter(IAT.all.useful,Error!=1)
rt<-correctIAT.all.useful%>%
  group_by(Subject,Block)%>%
  summarise(meanRT=mean(RT))

errorIAT.all.useful=filter(IAT.all.useful,Error==1)
errors=merge(rt,errorIAT.all.useful,by=c("Subject","Block"))
errors$RT=errors$meanRT+600
errors=select(errors,-meanRT)
rt.overall=rbind(correctIAT.all.useful,errors)

complete.table.SPSS=rbind(rt.overall,filterout)

rt.mean<-rt.overall%>%
  group_by(Subject,Block)%>%
  summarise(meanRT=mean(RT))
sd.p<-rt.overall%>%
  group_by(Subject)%>%
  summarise(SD=sd(RT))
sd.p.block<-rt.overall%>%
  group_by(Subject,Block)%>%
  summarise(SD=sd(RT))

block3and6<-rt.overall%>%
  filter(Block=="EList3"|Block=="EList6")%>%
  group_by(Subject)%>%
```

Appendix 9: Flyer Example 1

Appendix 10: Flyer Example 2

Participants wanted!

to experience a real Psychological Experiment!

Something new! We're interested in your attitudes about women in STEM (Science, Technology, Engineering and Mathematics) you will take part in an experiment where you will see a short text on a computer and react to stimuli on the computer screen with a keyboard. It is just like a computer game! Followed by a short questionnaire! It only takes 15 -20 minutes to finish. Also, for appreciation of your participation, you will be enrolled to a win a £100 Voucher! Please sign up now or email to me to make an appointment!

Room 441

St Andrews Building

School of Education

Or 7th floor

School of Psychology

58 Hillhead (next to the library)

Please contact: Jianshu Liu

j.liu.3@research.gla.ac.uk

A chance to win a 100 pounds voucher!

APPENDIX FOR PHASE TWO

Appendix A: Focus Group Discussion Protocol Development and Focus Group Guideline

Scoping exercise (Focus Group questions pilot)

Topic guide

Research objective

The aim of my research (phase 2) for focus group is to investigate the choices and barriers to face in the STEM study and career. Furthermore, to explore the underlying features/ factors have an impact that on career of women in STEM, and what strategies they used in terms of facing gender-science stereotype. At last, observed differences between two national groups.

Focus Group aim

1. To find out the perceptions of women studying STEM as a female STEM Ph.D. (researcher) —gender-science stereotype.
2. To explore the challenges and barriers when they achieved to this stage (women in STEM).
3. To explore what factors influence they pursue a career in STEM (including persons: role model or parents).
4. To further develop ideas for research

Design

This part of my research will involve several interviews with women in STEM and women in non-STEM. This will not contribute to my main research data for analysis, but instead will aid me in developing the questions I will ask for my research from several aspects.

Firstly, this will help me identify the specific questions about each theme comes from phase one. Secondly, this will help me practice controlling and following a standard procedure of the interview and focus group. Finally, this will help me the way I asked as a non-English speaker, benefit the way of asking the question clearly and properly.

Focus Groups Question Protocol and Guideline in English

Introduction
1. Introduction to me and the study
2. Explain the aim of this focus group in the wider context of my research
3. Explain the confidentiality and will be taking notes
4. They could offer me feedback when finish each question

Background
1. Grow up experience about STEM
2. When does the interest of STEM start?
3. Role model of STEM, parents or guardian working in STEM

Barriers and difficulties
1. Have you met any difficulties when you pursuing career in STEM?
2. Have you thought giving up and how you conquer it?

Gender-science stereotype
1. Have you encounter any gender-science stereotype, how?
2. How do you feel about it?
3. What do you think about women in STEM?

Anything else?
Are there any other issues you wish to raise?
Feedback from participants.
Is there anything unclear (language issue) or confused to you when I come up with specific question?

Chat question (when waiting, make sure what's their specific majors): Do you intend to work in STEM after you finish your PhD? Which occupation?

General instructions:
(everyone has been seated around the table: water in the cup and some sweets, chat with people that make them talk more later)

Hello, Everyone! My name is Jianshu Liu. Thanks for joining this focus group.
I have several questions about women studying in STEM subjects (STEM stands for science, technology, engineering and mathematics). The purpose is to get your own experiences and perceptions about female in STEM. There are no right or wrong or desirable or undesirable answers. You could answer the questions according your own experience, either reflect on others' opinions. It is a free and open to discuss. I would like you to feel comfortable with saying what you really think and how you really feel.

Recorder instructions
If it is okay with you, I will be recording our discussion. The purpose of this is so that I can get all the details but at the same time be able to carry on an attentive discussion with you. My college will help me record. All your comments and discussions remain confidential. I will use these comments and discussions in my thesis without any reference to individuals. I would like to add all your names to my Acknowledge to appreciate my deep thanks to you with your permissions.

小组讨论问题（提纲）Focus Group Question Protocol and Guideline in Chinese

正式开始前：确认每个人的学科（中英文名字）；毕业后会选择理工科的职业吗？哪个方面？

总介绍
大家好， 我是刘剑书。谢谢大家能够参与这次的小组讨论。本次讨论的主题和大家息息相关，是关于理工科女博士的，即“women in STEM”。“STEM”代表 science，technology， engineering 和 mathematics。在讨论当中的回答没有对错也没有倾向性。你可以根据你个人的经验参与讨论回答或者对他人的回答给予反馈。这是一个开放自由的讨论，请畅所欲言表达你最真实的想法。

在过程中我会进行录音，录音只用于帮助我后期研究。我的同事会帮助我录音。在这里所有的言论和谈话都会是保密的。我在使用这些作为研究材料的时候也会是匿名的，不会针对个人。另外如果你们容许的话我会把各位的名字放到我论文的鸣谢中，表达我最诚挚和的谢意。

下面请花一点时间阅读 information form 并且签署 consent form。（*顿一会*）

正式开始（*开始录音*）

问题：
（*运用语言，肢体语言和眼神接触试着让每个人都表达观点， 不要太多也不要不说，给予回馈并鼓励。*）

主题：从社会角度（刻板印象/文化影响）；他人影响（父母（养育人）/偶像榜样）；从个人角度（动机/态度）

Appendix B: Interview Question Protocol Development

Scoping exercise (Interview questions pilot)

Topic guide

Research objective

Given the context of underrepresentation of Chinese female in STEM fields, the women who working in STEM fields could be considered as successfully avoiding this gender-science stereotypical condition. Their experience and pathway to get what they stand for could help us understand how they achieve their STEM career so far. Therefore, the aim of this interviews is:

Interview aim

1. To find out specific experience/ characteristic that inspire Chinese women pursue a (successful) career in STEM—could be based on focus groups that some characteristics have already shown up.
2. To find out the differences between two national experiences as a female STEM researcher (career pursing successfully).
3. To explore the different experiences, they have between UK and China as a female researcher or in a working condition in STEM fields (if they have).
4. To further develop ideas for research

访谈问题（提纲）Interview Question Protocol and Guideline in Chinese

正式开始前：确认每个人的学科（中英文名字）； 毕业后会选择理工科的职业吗？哪个方面？

总介绍
大家好， 我是刘剑书。谢谢大家能够参与这次的小组讨论。本次讨论的主题和大家息息相关，是关于理工科女博士的，即"women in STEM"。"STEM"代表 science，technology， engineering 和 mathematics。在讨论当中的回答没有对错也没有倾向性。你可以根据你个人的经验参与讨论回答或者对他人的回答给予反馈。这是一个开放自由的讨论，请畅所欲言表达你最真实的想法。

在过程中我会进行录音，录音只用于帮助我后期研究。我的同事会帮助我录音。在这里所有的言论和谈话都会是保密的。我在使用这些作为研究材料的时候也会是匿名的，不会针对个人。另外如果你们容许的话我会把各位的名字放到我论文的鸣谢中，表达我最诚挚和的谢意。

下面请花一点时间阅读 information form 并且签署 consent form。（*顿一会*）

正式开始（*开始录音*）

问题：
（*运用语言，肢体语言和眼神接触试着让每个人都表达观点， 不要太多也不要不说，给予回馈并鼓励。*）

主题：从社会角度（刻板印象/文化影响）；他人影响（父母（养育人）/偶像榜样）；从个人角度（动机/态度）

Interview Question Protocol and Guideline in English

Introduction

1. Introduction to me and the study
2. Explain the aim of this focus group in the wider context of my research
3. Explain the confidentiality and will be taking notes
4. They could offer me feedback when finish each question

Background

1. Grow up experience about STEM
2. When does the interest of STEM start?
3. Role model of STEM, parents or guardian working in STEM

Barriers and difficulties

1. Have you met any difficulties when you pursuing career in STEM?
2. Have you thought giving up and how you conquer it?

Gender-science stereotype

1. Have you encounter any gender-science stereotype, how?
2. How do you feel about it?
3. What do you think about women in STEM?

Anything else?
Are there any other issues you wish to raise?

Chat question (when waiting, make sure what's their specific majors): Do you intend to work in STEM after you finish your PhD? Which occupation?

General instructions:
Hello, Everyone! My name is Jianshu Liu. Thanks for joining this focus group.
I have several questions about women studying in STEM subjects (STEM stands for science, technology, engineering and mathematics). The purpose is to get your own experiences and perceptions about female in STEM. There are no right or wrong or desirable or undesirable answers. You could answer the questions according your own experience, either reflect on others' opinions. It is a free and open to discuss. I would like you to feel comfortable with saying what you really think and how you really feel.

Recorder instructions
If it is okay with you, I will be recording our discussion. The purpose of this is so that I can get all the details but at the same time be able to carry on an attentive discussion with you. My college will help me record. All your comments and discussions remain confidential. I will use these comments and discussions in my thesis without any reference to individuals. I would like to add all your names to my Acknowledge to appreciate my deep thanks to you with your permissions.

Information/Consent form instructions
Before we get started, please take a few minutes to read the information form (send before they come) and signed the consent form. It will take around 1 hour or so.
(send out the Information Form and Consent Form, begin to record)

Appendix C: Focus Group (UK) Transcripts

UK Focus Group at 16. 07 pm, level 5 in university of Glasgow library

R Question 1. When did your interest in STEM start? How was your performance on mathematics? Like when you were in high school, college? When did you start your interest in STEM as a child? Like mathematics, chemistry physics and biology?

P1: Shall I start? (if you want to, one of the other participants) I was always interested in sciences and maths- then I did a law degree, and I was an accountant, and then I was a teacher and I enjoyed teaching science to primary school children. Then a few years later in 2014 I moved to Glasgow, I was always interested in health, I started in working and did a MSc in Health Economics ***(R: what kind of work?)*** was interested in the financial side in health. ***(R: when did you start your interests in mathematics?)*** oh, I was always interested and good at maths in school. ***(R: is there a certain time?)*** I was always interested in math and science, but Health is just an interesting context.

P2: So, I have a similar path. It is quite the same. I was always interested in biology in school- the thought that I am going to medical but did not end up doing that instead accountants and no maths and emm I had kids and just worked around children. I wanted to take all to do something different of my career to do I decided to want to go into health and stay with mass science cus things that I wanted me to train completed. So, I went into health economics like Person 1 as well, so I tried science and that kind of things. okay I was interested in biology that was my really favourite subject in school.

(R: Why do you like biology?)

P2: Because you can apply it to real life. Maybe you learn geography you can say what you are learning about, but biology was something that you can relate to life.

P3: I was always interested in maths and sciences at school. and I was very lucky that I had very good teachers at high school and very good supports that around me. I was always to encourage to do well and studied hard. And I was never told that I couldn't do anything. And because all the reasons my teachers in high school more encouraged me going into law actually. When I started to do it I realised that I would miss maths and dropped out of law during Fresher's Week. And I am almost falling my way through and finding statistics and I did a master found a workplace and doing a PhD, cus I am good at it and enjoying, I guess I enjoy it cus I can do it. Statistics is just an applied to mathematics, the second year of math is really hard, I was gone off. But Statistics is just an applied mathematics and real-life data, so it is more interests to myself.

R: So, you talked about your teachers when you were a child to encourage you?

P3: I never had such experiences that I knew some girls find that not encourage to do math I never had that at all. I was always encouraged by my parents, my family, my friends and teachers. it was not older that I realized that there was a problem with women in STEM cus all through my life It was just a girl that doing math.

(R: lucky, was there a person having impact on this like a role model?)

P3: I'd say parents and teachers. (they never gave you disadvantage information from them) I was just always, again get the grades being the top of my class.

Appendix D: Focus Group (China) Transcripts

R.现在进入第一个问题，那么什么时候开始对理工科产生兴趣？

W1.从自己能读书开始

W2.我应该也差不多，从很小的时候就觉得自己比较适合理科

R．为什么觉得自己适合理科？

W1．可能理科需要的操作比较多，就是做实验之类的。我最这些比较感兴趣。我记得小时候还有什么自然科学课之类，里面有很多小实验，当时每一个我都要自己做做试试。

W2.我是高中时必须分文理科，我对所有学科都感兴趣（笑）。而理工科里面可以选择的专业比较多，所有我选择理工科。

W3.我和她基本相同吧，但根绝刚才的讨论，我觉得我更适合文科（笑）。我本来是想学医院的，牙科或者妇产科。和你现在做得不矛盾么？不矛盾，高考阴差阳错进入生命科学这个领域，我内心还是很向往文科的。这个不矛盾，你可以有向往，也可以同时做好自己的事。

W4.从小学开始，理工成绩比较好，也就一直学下去了。成绩好，大概什么程度？数学比较好，经常参加竞赛，再就是物理化学成绩好...所以就一直这样下来

W5.小学时，看电视（笑），看 discovery，很喜欢动物，相当动物学家。后来定方向，就越变越多。那你现在专注于当前方向是因为？喜欢！总的来说大家选择理工科主要是因为，小时候理科的成绩就不错，兴趣也比较早，小学 初中之类？

W6.但是我小的时候，文科方面的成绩会比理科更好。大家会觉得我的语文挺好的，英语也挺好的。语言能力比数学那些要强。我在高二分文理科的时候，班主任还跟我谈，希望我学文科，但我还是偏执地选择理科。一方面那时我的理科成绩也不算差，另一方面我认为理科不同专业的学习是无法自学的，但文科可以以后自己看书。也不一定要在年轻的时候学，你现在对社会学之类感兴趣，现在也可以学。

Appendix E: Interview 1 Transcripts

Interview Post-Doctor Participant 1

R1. 第一问题是，你什么时候开始对理工科产生兴趣，小学，初中，或者其他？

P1. 呃...我觉得我主要对理工科有概念是上大学之后吧。因为第一年的时候主要是一些基本课程，就像物理、化学之类的东西，其实是当时才对理工科具体要求干什么有一个初步的概念。

R2. 你对理工科有概念的时候也就是对它们产生兴趣的时候么？

P1.产生兴趣，我对于理工科产生兴趣的时间点其实非常晚。我是到已经到决定要读 Master 的时候，自己要做 Project，那时候才感觉到，诶，好像搞研究、做技术、还是蛮好玩的。

R3. 所以你是进入到比较高阶的教育阶段才开始感兴趣？那你具体感兴趣的点是？

P1. 对！呃... 因为本身 engineer 的方向是说，假如我设计一个 model，然后我就可以得到一些结果吧...那个结果是非常直观的。比如说我这东西（model）可以工作了，然后工作状态非常好。在那个情况下我就会感觉说，诶，有一种成就感。

Q4.在这个过程中是否有一些关键时刻或者事件，直接导致你将理工科确定为未来的事业？

Appendix F: Interview 2 Transcripts

Interview Post Doctor participant 2

R1:你什么时候开始对理工科产生兴趣？小学、初中、高中，或者其他？

P2: 小学吧...我从来就没有对文科产生过兴趣（笑）。应该是小学的时候我数学成绩比较好，数学对于我比较简单，一直都是 100 分（笑）。所以你一直认为数学对你很简单？是的，我觉得数学简单，一直觉得语文太难了，我特别讨厌写作文。所以你似乎天生就喜欢理科，没有什么原因。对！ 没什么原因。那你身边有没有什么人，比如家长，朋友之类，鼓励你学理科？好像也没有，我爸妈都很尊重我的选择，而且我家也非常明确我不太喜欢文科，类似地理啊，那些需要背的东西...我也没有太喜欢语文，似乎我和语文总有些障碍，一直以来，我还是觉得数学比较简单。觉得数学比较简单也促使你进而喜欢理科？对！有什么关键的点使得你决定将理科作为事业么？从开没有，就是一个顺理成章的事。除了觉得数学简单之外，还有什么原因或者动机让你喜欢理科么？呃...好像也没有什么特别的动机，主要还就是觉得比较擅长吧，再加上对文科的没有兴趣。插一句题外话，你小时候喜欢玩娃娃或者小汽车么？不太喜欢娃娃，小汽车也不太喜欢，我小时候喜欢看电视。另外我喜欢下象棋、下跳棋、打扑克...和姥姥姥爷。虽然还是爸爸妈妈生活一起，但寒暑假都会到姥姥姥爷家。假期也是玩的最多的时候吧...另外，我好想都不太想的起来我还有什么同年玩具（笑）。

R2: 你有没有什么职业上的偶像，家人啊，长辈啊，你以后想成为的样子之类？

P2: 呃...我好像想不起来谁是我的偶像，(思考)...我小时候想过当一个新闻工作者，但那和理科什么关系都没有啊... 主要是因为我爸爸是新闻工作者，他觉得那个圈子比较复杂（不是很赞同）。你妈妈的职业呢？医生！那你妈妈算是理科了，这对你有什么积极影响么？可能工作（态度上）比较认真吧。那你家人就是你妈妈是理科？我爸爸大学本来是学物理的，后来转行做的媒体工作。但对我理性思维上的影响还是有。我爸爸主要对文科更感兴趣，还生活一些物理现象之类，还是会表现出一些

Appendix G: Interview 3 Transcripts

Interview Post Doctor Participant 3

R1:你从什么时候开始对理工科兴产生趣?

P3: 高中吧。为什么？因为我发现我的文科学的不太好（笑）...就是对比，你在一方面做得不太好，在另一方向做得相对比较好。你之前有什么苗头么，关于文理科的这种差异。小学和初中都还比较平均，到高中的时候必须要分文理科了，所以一定要选择一个。其实我的文科并没有那么差，只是我觉得文科的学习过程很痛苦，因为我不喜欢背诵啊这类的。那你理工科里最擅长哪一门？我觉得我那时物理挺好的。数学呢？以 150 分制来衡量的话？应该在 120 以上吧！

R2:在选择了理科之后，后来的学习中有什么困难么？你大学专业是？

P3: 我大学的科目是环境科学，主要是和生物、化学有关的东西，有机无机什么的。为什么选择这个专业？这个话题很长啊...其实高考完选择专业的时候，我前两个专业报的是金融（笑），因为我选择的那个学校金融专业最强。而第三个专业是英语，因为我自己本身喜欢英语。第四个专业才是环境科学，那时候国内对环境问题比较重视。这些专业选择都是工作导向？没有，英语就不是。而且那时候选择专业时也不清楚之后是怎样的学习过程，毕竟高中的时候也没有人介绍这些。一切都是进了大学之后才知道学什么专业时什么样子。你进大学后对所选专业的第一印象如何？就是...（思索）没有什么印象吧...(笑)，因为它很多都是化学，然后化学里面有一部分是背的，有一部分是计算或者理解的。属于文理属性还算平衡的。你什么时候决定将来就从事这个行业了？我从来没有决定如何，一直都是顺水推舟。一

Appendix H: Interview 4 Transcripts

Interview Post Doctor participant 4
(开始有些紧张， 对问题的理解和表述缺乏思考， 后面放松以后开始侃侃而谈）
11/10/18 17:00 G12 café （背景音乐略吵闹）

R1: 从什么时候开始对理工科产生兴趣？

P4：高中时候必须分文理科，很自然的选择。 没有选文科的原因是不太喜欢地理，但是我比较喜欢数学（高中数学成绩是？）140/150.

我小时候比较喜欢男生玩儿的东西， 踢球。我觉得这也是一个刻板印象。自动认为男生就会选择理科，就因为我的性格比较象男生，所以我才会选择理科。同时也可能是同样的原因，大家认为男孩该选择理科的多一些。

以前家里人劝我选择经济类或者法学类的专业，我不是很喜欢（觉得太女孩子了专业）。虽然现在我觉得这些专业都挺好的， 但是回到高考抉择的时候， 我是非常明确的做出选择的。我只学工科，不学法律，金融，我觉得这几门课比较简单。医学（有点害怕）不选。而理工科比较有挑战。

我将来想做学术的研究员，因为国内如果不做研究员，就需要进入企业，而国内的人际（人事）关系比较复杂，我不是很擅长这方面。这并不是学术方面的问题，而是人群之间的勾心斗角。而我比较喜欢安静的坐下来研究。

R2: 有没有什么历史性的关键时刻在你学习理工科的过程中？比如你什么时候决定选择理工科作为你未来的事业？

P4：我喜欢数学的原因， 可能是因为小学的时候比较喜欢做【思维训练】里面的数学题，里面的数学题，不是课本里面出现的传统题目，发散思维的题目。（做数学题比较有意思，乐趣？）对！

另外，没有一个决定的时候（作为未来事业）高中分班在理科， 大学很自然的选择理工科专业。（那对大学专业的选择是？）我最开始想学生物，但是咨询了相关的人之后，生物专业在国内不太好找工作。后面就选择了相对好找工作（和生物比）的光学（物理）。（那后面有没有自主选择过专业或者方向？）在本科和研究生阶段都是学习物理方向（光学）， 但是现在（博士后阶段-生物医学）有和生物想结合的物理方向（生物医学+光学）， 于是又回到最初兴趣的（生物）并结合所学（光学）。

（为什么放弃国内来到国外做博后？）我在国内也收到一些工作 offers， 但是不是特别满意，对那些方向没有什么兴趣。国外刚好有我感兴趣的方向， 于是就来了。而且因为如果国内的方向不喜欢，那么工作起来应该不太开心。

我还有另一个原因选择理工科，我不善言辞，可能觉得理工科不需要特别能说就行。

R3: 关于影响选择的因素，在你孩童时期，有没有榜样，来自人的？

Appendix I: Coding Marks (examples)

1. 产生兴趣时间，喜欢理科工原因： timing of start interests in STEM / Why / reasons of interests in STEM

2. 决定性事件： key moment / issue ~~for begining~~

3. (理工科) 榜样： role model (STEM)

4. (理工科) 遇到困难 / 克服 / 放弃： Obstacle / Difficulties, how to conquer

5. (理工科) 女生的 (特别的) 性格、特性： characters / personality (STEM)
男性、女性研究者性格、特性：

6. 对 (女性) 理工科期待 { 社会 / 家庭 — 中国受访者： social expectation to female in STEM (especially for Chinese).

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7. 对 (理工科) 女性的刻板印象： stereotype for women in STEM

8. 高知女性、读博女性 (理工)： stereotype for women with PhD degree

9. 国内外对女性差异： The differences between UK and china for women in STEM

10. 建议： suggestions.

Appendix J: Coding Example with Manual Transcripts (the UK Focus Group)

16. 07 pm

Question 1. When did your interest in STEM start? How was your performance on mathematics? Like when you were in high school, college? When did you start your interest in STEM as a child? Like mathematics, chemistry physics and biology?

When:

Person 1: Shall I start? (if you want to, one of the other participants) I was always interested in sciences and maths- then I did a law degree, and I was an accountant, and then I was a teacher and I enjoyed teaching science to primary school children. Then a few years later in 2014 I moved to Glasgow, I was always interested in health, I started in working and did a MSc in Health Economics ***(JS: what kind of work?)*** was interested in the financial side in health. ***(JS: when did you start your interests in mathematics?)*** oh, I was always interested and good at maths in school. ***(JS: is there a certain time?)*** I was always interested in math and science, but Health is just an interesting context.

"always interested in"
Rasons: good at math & interested in

Person 2: So, I have a similar path. It is quite the same. I was always interested in biology in school-the thought that I am going to medical pradi…..but did not end up doing that instead accountants and no maths and emm I had kids and just worked around children. I wanted to take all to do something different of my career to do I decided to want to go into health and stay with mass science cus things that I wanted me to train completed. So, I went into health economics like Person 1 as well, so I tried science and that kind of things. okay I was interested in biology that was my really favourite subject in school.

try something different of career
interested in biology

(JS: Why do you like biology?)

Person 2: Because you can apply it to real life. Maybe you learn geography you can say what you are learning about, but biology was something that you can relate to life.

apply to/ related to real life

Person 3: I was always interested in maths and sciences at school. I never had this thought and I was very lucky that I had very good teachers at high school and very good supports that around me. I was always to encourage to do well and studied hard. And I was never told that I couldn't do anything. And because all the reasons my teachers in high school more encouraged me going into law actually. When I started to do it I realised that I would miss maths and dropped out of law during Fresher's Week. And I am almost falling my way through and finding statistics and I did a master found a workplace and doing a PhD, cus I am good at it and enjoying. I guess I enjoy it cus I can do it. Statistics is just an applied to mathematics, the second year of math is really hard, I was gone off. But Statistics is just an applied mathematics and real-life data, so it is more interests to myself.

interests. good teachers / supports.
real interest in maths
good at / enjoy it

JS: So, you talked about your teachers when you were a child to encourage you?

Person 3: I never had such experiences that I knew some girls find that not encourage to do math I never had that at all. I was always encouraged by my parents, my family, my friends and teachers. it was not older that I realized that there was a problem with women in STEM cus all through my life It was just a girl that doing math.

so encouraged all the time by people around her.

(JS: lucky, was there a person having impact on this like a role model?)

Person 3: I'd say parents and teachers. (they never gave you disadvantage information from them) I was just always, again get the grades being the top of my class. Do my (missing)

role models (!) parents and teachers

Appendix K: Focus Groups (UK) Codes and Themes

Focus Group Codes and Coding (UK)

UK Group

1. When did you start your interests of STEM? / Why did you choose STEM?

Raw Data	Preliminary Codes	Final Codes	Category	Themes
always interest in sciences and maths	No specific time, always interests	Always Interests	Influence time/ reasons	
was always interested in health	Since college			
I was always interested and good at maths in school.	Since little			
I was always interested in biology in school	Since high school			

2. Why do you think you are suitable for STEM? / Why did you choose STEM? / Why do you like STEM?

Raw Data	Preliminary Codes	Final Codes	Category	Themes
I wanted to take all to do something different of my career	Learn all and different	Interests driven; good at them; practical to life; eager for knowledge; get encouragement and support f	Reasons	
you can apply it to real life… you can relate to life	Practical to life			
I had very good teachers at high school and very good supports that around me. I was always to encourage to do well and studied hard. And I was never told that I couldn't do anything… it is more interests to myself.	Encouraged and supported; "I was never told that I couldn't do anything"; interest			

Appendix L: Focus Groups (China) Codes and Themes

Focus Group Codes and Coding (Chinese)

Chinese Group

1. When did you start your interests of STEM?

Raw Data	Preliminary Codes	Final Codes	Category	Themes
从自己能读书开始	When started to read	Interests start earlier(realized)	Influence time	
从很小的时候	"when I was little"			

2. Why do you think you are suitable for STEM? / Why did you choose STEM?

Raw Data	Preliminary Codes	Final Codes	Category	Themes
可能理科需要的操作比较多，就是做实验之类的	Many practical works; like to do experiments	Interests driven; the choice of Chinese college entrance exam; better grades of STEM; eager for knowledge	Reasons	
我是高中时必须分文理科…而理工科里面可以选择的专业比较多，所有我选择理工科.	Had to choose because Division of science and arts when in high school; more choices of subjects in STEM than arts in university.			
高考阴差阳错进入生命科学这个领域.	The choice of Chinese college entrance exam			
从小学开始，理工成绩比较好，也就一直学下去了…物理化学成绩好.	Great grades of STEM (chemistry and physics) since primary school			
很喜欢动物，相当动物学家。后来定方	Like animals (being a zoologist)			

Appendix M: Interviews Codes and Themes

IPA ran for each interview participant first and then findings and results across all interview participants by emergent themes
Red mark words thoughts compared with focus groups
Interview1

P1: Female Post Doctor participant 1
Ideal job after post-doctor: Researcher/Lecturer

Emergent themes	Original Transcript (translated into English)	Exploratory comments
Timing: Late interests	(line3-5): Emm…I began to have concepts about science and engineering after I went to university. Since the first year of basic subjects, such as physics and chemistry, I have a primary concept about what I gonna do. (line8-10): I was quite late when I have actual interests to science and engineer when I was at my Master doing a project. I felt it (pause) seems enjoyable and having fun to do research and technical staffs. (12-15): R: (according to what you said) you began your interests to STEM when you were in a higher-education level? What kind of things most interests you? P1: Yes! …I conduct one model, then I have results which are very visual to see how it works. if it works well, …I feel a sense of achievement.	Timing of STEM: Think for a while to realize when she had interest in STEM. Interests of STEM started Very late: Master Cognition of STEM: not have a clear clue about what are STEM for before college. When it comes to practical staffs, she realizes this might be her thing. Internal thinking: She was wondering and confusing about what she like and doing before college. Tend to do something practical: When she got into a project and see the results, she finally has sense of achievements and goals.
Interests found Internal and external motivations	(19-23): I was always knowing that I have to stay in this field since I went into university… because back in china, it's really hard to get a job in company, doing science and engineering things, if you only have an undergraduate degree in my field. The companies require you have a master's degree, if you're only have an	Job direction from society: the company requires a degree (at least master) to do something about techniques, she needs to a degree. After she get into it, she found interests in it, because it's practical and helpful to people. Interests for STEM: grow when practise in the fields

Interview2

P2: Female Post Doctor participant 2
Ideal job after post-doctor: something in health consulting and health industry (no need to learn new skills all the time)

Emergent themes	Original Transcript (translated into English)	Exploratory comments
Timing: primary school, Reasons1: nature love to STEM	(2-6) primary school, I never show love to Humanities…mathematics always is easy for me…I found Chinese was hard for me, I hated writing…no special reasons why I am interested in Math…this is quite nature.	Found her nature love (easy) to Math earlier in primary School
Parents attitude	(7-9) Parents respected my choices (to STEM), they know I don't like Humanities, something that needs to remember…	Parents respect to her choices
Favourite toys and games when childhood	(14-15) I didn't like playing dolls and cars. I like watching TV… and playing Chinese chess and pokers…	Logical games: Chinese chess and pokers
Role model	(20-27) …I was dreaming of being a journalist because my father was…but my father would not agree with that…my mother is a doctor…she has an impact on me doing work seriously…my father was in physics in college, he has an impact on my rational thoughts…also, he would explain physical phenomena in life…	Both parents have implicit positive impact on her from attitude to work (serious) and thinking styles (rational).
Reason2: apply to real life and good at maths	(33-46) …I like the field of health economic because no need for experiments, I am not practical at all…I prefer play with data, more statistics and maths. Actually, the reason why I chose this because it applies to real life and no experiments. This could give me more motivation to	Not practical and not good at experiments. Prefer to play with data Apply to real life: women tend to do things are related to real life.

Interview3

P3: Female Post Doctor participant 3
Ideal job after post-doctor: researcher in non-academic institute (stable and less challenge)

Emergent themes	Original Transcript (translated into English)	Exploratory comments
Timing: high school	(3-8) high school…I found myself doing relatively better on STEM than Humanities subjects in high school…I had to choose between two…actually, I was not that bad at Humanities, I hated to remember…I was quite good at physics…>120/150 on Maths.	She had to make a choice, relatively not willing to study Humanities in high school.
Reason: Chinese college entrance examination	(11-23) I studies environment science when I was undergraduate, including biology, chemistry and etc…actually this was not my first choice of majors, the first two were finance, the third was English, because I like, this the fourth choice, because that's popular in China to find a job…they were all presumed to be popular to find a job, expect English…but I really didn't know because no one told us what these majors could do… everything became clear to me after I got into the university…I never choose what to learn, it just went naturally…for instance, I was chosen to study specific majors when I was postgraduate …I had no alternatives for me…I had to choose the relevant subjects when get into PhD…	Common things with other women in STEM: she didn't know much about what different majors like in realistic before getting in the university, so she chose majors by chances or by job opportunities. This lack of knowledge before getting into university leads to many women or students giving up the opportunities in STEM. some of these women got into by chances.
Role Model: female in Huminites, lack of female role model in STEM	(27-32) actually, I don't have any role model (in STEM), my dream was to become a English teacher when I was young…I was quite fond of English (when I was	Again, the major choosing was not an interest just weight the advantages and disadvantages for future after the Chinese college entrance examination.

Interview 4

P4: Female Post Doctor participant 4
Ideal job after post-doctor: researcher in academia (not much interpersonal relationship)

Emergent themes	Original Transcript (translated into English)	Exploratory comments
Timing: high school	(6-7) It's nature to choose from Humanities and Science in high school. I don't like geography, but I prefer maths (140/150)	Good at maths, nature choice for science class.
Children games	(8-9) I preferred boys' games and toys when I was young…I might think automatically that men chose science subjects, I have boys' characters, so I would choose science.	Boys' game and toys, she has implicit and explicit association between men and STEM. She has boys' characters, she chose to study STEM.
Parents (family) P4 attitudes towards major chosen	(11-17) My parents persuade me to study economic and law, I wasn't approved, I thought that was too much girls' subjects. even I find these subjects are all fine, back to the (Chinese college entrance) exam, I would still study engineering, no law and economic, they were easy to study…I found engineering quite challenging.	She's independent on making her own decision, not affected by her parents. She likes to learn something "challenge", refused to learn easy or girl-like subjects. Why did she refuse to play "girls' games", learn "girls 'subjects"? She deeply associates Men with science and challenging (powerful) job.
Future job: researcher in academia	(15-17) I am willing to be a researcher in the future. As in China, if you would like to not to be a researcher, that will end up in companies, I hate the complicated net-working with people, I am not good at it. Because it's not academic issues…I prefer quiet and doing my research.	To be a researcher instead of office lady because she hates net-working with people.
Reasons for why interest STEM	(21-23) the reason why I like maths, because I was fond of doing maths exercises when I was in primary school, the exercises were not the	she developed her interests to maths at primary school. Science and art separated education and then kept in university.

Appendix N: Summary of Interviews Codes and Themes

When did you start your interests of STEM?

Raw Data	Preliminary Codes	Final Codes	Category	Themes
Post1 我觉得我主要对理工科有概念是上大学之后吧… 产生兴趣，我对于理工科产生兴趣的时间点其实非常晚。我是到已经到决定要读 Master 的时候，	When started to do research	Interests start late after college or even doing a PhD (realized) After doing research, naturally started interests	Influence time	
Post2 我从来就没有对文科产生过兴趣（笑）。应该是小学的时候我数学成绩比较好，数学对于我比较简单，一直都是 100 分（笑	Nature/high math grades in primary school			
Post3 高中吧。因为我发现我的文科学的不太好	High school			
Post 4 高中时候必须分文理科，很自然的选择	No timing, has to choose in high school			

1. Why do you think you are suitable for STEM? / Why did you choose STEM?

Raw Data	Preliminary Codes	Final Codes	Category	Themes
Post1 自己要做 Project，那时候才感觉到，诶，好像搞研究、做技术、还是蛮好玩的。那个结果是非常直观的。比如说我这东西（model）可以工作了，然后工	Interests to research(gradually): results are practical; sense of achievement; the results could help people	Interests driven; good at science subjects achievement; practical, related to real life (help people)the choice of Chinese college entrance examination; not good at Humanities, networkings.	Reasons	