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Female Underrepresentation in STEM Subjects: A Study of Female High School Students in China

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ABSTRACT

In Chinese education, there is a conflict between girls' socialized gender norms and the values and pedagogies that are incorporated in the science curriculum. These are influenced at both the micro- and macro-level of institutions and often discourage female students from choosing science courses, pushing them into social science instead. In order to ensure that female students have the same opportunities to reach their potential in science areas, it is important to understand the factors that influence their choices. This study investigates the potential reasons why female high school students in China are less likely to choose STEM subjects and direction. By conducting qualitative interviews with six female students, in two Chinese high schools, who have been enrolled in social sciences courses, the study discovers several factors, including the influence of current sciences curriculum, teachers, labor market, parents, and peers, behind their decision-making behaviors. The findings of this study enrich existing research on gender equity in science community by exploring the gender issue in Chinese high school education and provide a direction for future research on this topic while informing policies that can address gender disparities in science programs.

Keywords: Chinese high school education; gender equity; STEM; female underrepresentation

DEDICATION

To myself

To my parents

To all the people who helped me through this process

To all Chinese high school students

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CHAPTER 1

Introduction

In grade 11, Chinese high school students are often required to make a choice between focusing on the arts—which include disciplines such as geography, politics, and history—and the sciences—which include physics, advanced math, biology and chemistry. Students will be reorganized into new classrooms, receiving different curriculums according to their selection, and will likewise receive a specialized version of China's national university entrance exam: Gaokao. The selection between arts, also referred to as social sciences, and the sciences is considered as one of the most significant events in students' academic study, not only because it means that students can have the chance to further explore a specific field or area according to their selections, but also because it determines students' academic directions and opportunities in higher education and their future careers.

However, there is always an imbalance of gender ratio in sciences direction (Ma et al., 2016). Many universities, like the University of Science and Technology of China, which features science-related majors, found that the percentage of male first-year students was much higher than the proportion of female first-year students. As to arts-related universities, the situation was the inverse. Ma et al. (2016) found that 2009 marked the first time that female undergraduates outnumbered male university students, and in 2013, female students accounted for 51.75% of all undergraduates. However, the Statistics of National Universities showed the top 10 most popular majors for boys, were all science, technology, engineering, and mathematics: the STEM subjects. Moreover, the proportion of boys was more than 80% in these majors. Female students tended to cluster in social science majors, and as a result, the number of female undergraduates in social science majors (including sociology, education, Chinese language and literature, foreign language and literature, journalism and communication, art and psychology) was double that of their male counterparts (Fan, 2011). The differences in these data imply girls' underrepresented participation and the lack of interests in STEM subjects.

Blossfeld and Buchholz (2009) note that with a given household, women are typically responsible for housekeeping, maternal/paternal duties, and providing support for their husbands. Conversely, men are often regarded as breadwinners. Women's social activities are limited to housework and their values are judged according to whether or not they can effectively care for children, elders, and husbands. Thus, it is understandable why gender segregated schools in the nineteenth century educated boys and girls with different types of curriculum. At that time, the focus of girls' education was domestic skills and moral contents for better accomplishing traditional female responsibilities, even though the academic curriculum at the end of the nineteenth century had been designed for girls who planned to continue their academic study (Murphy & Whitelegg, 2006). Hierarchical levels existed at the original design of curriculum. Mathematics and science, which were seen as challenging and important, were considered masculine and were designed to cultivate middle- or upper-class boys to be elites or leaders. In contrast, subjects such as languages and arts, which were as easy and less important, were considered feminine and were designed for women (Skelton et al., 2009).

Chinese history illustrates deeply rooted gender gap and different opportunities for boys and girls. In Imperial China, specifically the Ming and Qing dynasties, the social status of women was so much lower than men that girls were allowed to participate in neither the imperial civil service examination nor Chinese traditional private schools (Goodrich, 1982). The widely accepted, or ‘ideal’ marriage age for girls was their teen years, so girls’ education was often viewed as unworthy of the time and money it would require (Liu, 1998). In other words, girls were completely excluded in education. When it comes to modern China, women activists have struggled to gain equal access to formal education. As a result, “the first Chinese school for girls opened in 1898”, a period with “dramatic social and cultural change” (Bailey, 2006, p. 2). However, women were still primarily educated to serve their family members as housewives, mothers, and caregivers. In terms of the curriculum design for girls’ education, Bailey (2006) points out that

> The school apparently paid particular attention to ‘household and family matters’, with practical lessons being devoted to learning clothing materials, examining the nutritional value of different kinds of food, and acquainting students with the correct way to ventilate rooms, use fuel and maintain household objects (p. 2).

Although several studies have found that women have made impressive achievements in recent decades, especially in tertiary education; however, their enrollment and participation in STEM subjects are still lower compared to their male counterparts. Thus, Clandfield and Martell (2014) conclude that "Girls' academic accomplishments have been very much slanted away from the areas of math and sciences—a skewing maintained throughout their secondary and post-secondary schooling careers" (p. 232). Moreover, even female students who perform well in STEM subjects often lack the confidence required to pursue a STEM-related career with persistence. This is demonstrated by Avalon (2003), who observes that "Women are underrepresented among the applicants to the mathematics-related fields of study, although they rely on high qualifications more than men when applying to selective and male-dominated fields of study" (p. 227).

Need for the Study

Globally, the existing gender gap in STEM fields remains a problem because it not only negatively influences female's self-attainment and self-development, but also reduces the gender diversity of human resources in STEM fields. To maintain the competitiveness in a globalized world, any country or industry cannot afford the risk of losing any potentially outstanding labor force in science fields (Dasgupta, Scircle, & Hunsinger, 2015). Thus, it is essential to explore and understand what factors contribute to this gender gap in education. Several countries took actions to narrow or eliminate the gender gap in STEM fields, not only because it is the requirement of the nature of education, but also because it can bring a positive influence on socioeconomic development. In addition, it is important to prioritize the performance of female students in mathematics and the sciences as these students, through their future roles as mothers, will make society more science literate (Mulemwa, 1999).

However, in developing countries, there is limited research on female's contribution and participation in STEM areas (Huyer & Westholm, 2007). Empirical studies focusing on perceptions and experiences from students' standpoint are also limited. In China, for example, though several Chinese studies highlight female inhibitions in science community, most research focuses on the secondary data analysis and document comparison (Ma et al., 2016; Wang, 2003; Xiao & Huang, 2010). As a result, these studies fail to consider critical components of China's education system when trying to develop a comprehensive understanding of the field. A number of studies have explored the relationship between female students and science education through empirical investigations that use quantitative or qualitative methods (Dasgupta et al., 2015; Friedman-Sokuler & Justman, 2016; Legewie & DiPrete, 2014; Riddell, 1989); however, these studies did not investigate Chinese social or cultural contexts or its education system.

In addition, most researchers regard the stage of university as an explanation of the gender gap in career trajectories, so that their studies concentrate on post-secondary education to understand female students' career orientations and potential influencing factors in STEM fields (Legewie & DiPrete, 2014). Though helpful, researchers have concluded that boys' and girls' exposure to stereotypes happens during their early childhood, much earlier than university years (Tai, Liu, Maltese, & Fan, 2006). This is especially true during their adolescence, which is a more salient period both for identity formation and career aspirations (Master, Cheryan, & Meltzoff, 2015). As for self-identity, female students often struggle with internal conflicts related to opposing self-attributes during adolescence (Harter, 1990). In terms of career trajectory, children start to consider what kind of job they prefer and make career decisions at the age of five (Lupart & Cannon, 2002). Legewie and DiPrete (2014) also suggest that the schooling experiences in high school have more powerful influence than in university years with regard to decreasing the existing gender disparities in STEM fields.

Considering the existing gaps in current research, this study will explore girls' personal experience at high school and the gender stereotypes in the context of China.

Purpose of the Study and Research Questions

This study aims to investigate why female high school students are less likely to choose STEM-related subjects and career direction in the context of China. By interviewing female high school students who have registered in social sciences direction after Grade 11, the study focuses on the potential influencing factors behind their academic inclinations. The potential findings of this study can provide implications for educators, school administrators and policymakers to understand female's underrepresentation and eliminate the gender gap in STEM fields. Based on the input of the participants, the current study also aims to provide a clearer understanding regarding gender equity in science community by gaining intimate insights into the gender issue in China. Two central research questions will guide this study:

1. How do Chinese female students make academic decisions during their high schools between the two education directions— Arts (social sciences) and Sciences?
2. What potential factors contribute to the gender disparity in sciences direction in the context of Chinese secondary education?

CHAPTER 2

Theoretical Framework

Feminist Critiques of Science

In the 1970s, many feminist scholars and scientists began to realize that just as other parts of society were reexamined based on new feminist perspectives, science should likewise be revised. Civil rights and the women's movement emerged in the 1960s. This was reinforced, as Barton (1998) notes, with the national goal of "science for all" in the 1980s, which sought to improve all students' scientific and conceptual literacy in the United States and which underscored the notion of gender equity in science education within the science community. Barton (1998) states that there is an urgent need for science teaching to create an inclusive and gender-friendly environment to make science accessible for all students, regardless of race, gender, or social class. The first wave of feminism had a profound impact on making early connections between feminist theory and science education. It focused on how women and minorities were marginalized in school, especially in science-related activities, and explored way to create more opportunities to increase girls' confidence and scientific ability to get more involved in science (Kahle & Meece, 1994).

However, neither science nor science education was critiqued in terms of the nature of science and the ways of knowing until second wave feminism in 1980s (Barton, 1998). Harding (1986) and Longino (1989) question the existence of purely objective, independent and unbiased knowledge in science because scientific inquiry is subject to socioeconomic interest. It is impossible for scientists, as human beings, and science, as a discipline of society, to divest themselves completely of their relationships with social or cultural forces. Harding (1986) also points out that in Western science, which was valued and organized by European, middle- or upper-class, male-oriented worldviews, promoted androcentric assumptions that “appear in the collection, interpretation, and use of the data” (p. 96). This could marginalize large parts of students who prefer a different way of knowing. Women’s way of knowing, which prefers “relationships, connections, and caring” instead of “reason, logic, mechanism, and reductionism”, was undervalued or even devalued in masculinized science world (Barton, 1998, p. 8).

The second wave feminism brought more light on the narrowed and distorted values in science education. Scholars during this time affected the practices that created gender-inclusive science. For instance, Harding (1991) suggests that science teaching methods should “stress context rather than isolated traits and behaviors, interactive rather than linear relations, [and] democratic rather than authoritarian models of order” (p. 300). For science teachers in preparation, it is difficult but necessary to develop a thorough understanding of science teaching and learning in order to motivate students with diverse experiences. Science teachers should realize that science is much more than acquiring facts, formulas, and theories (Barton, 1998). They should notice that the science classroom activities and teachers’ position of authority would contribute to students’ narrowed definition of science (Edward & Mercer, 1987).

With more attention paid on the three dynamics— race, class, and gender—the third wave feminism significantly influenced the science community by "challenging science as a school subjects… [and] challenging the roles of teachers and students" (Barton, 1998, p. 16). Both schools and teachers associated closely with the cultural, political, and social constructions. Kincheloe (1993) also points out that teaching science should not be independent to the large contexts of society. By re-analyzing the role of science, teachers can help students create "new representations of science" that make sense of science in their lives "both inside and outside the community of scientists" (Barton, 1998, p. 18).

Social Construction of Gender and Social Learning Theories

There is always an inevitable link between individual's behavior and social environment. Mead (1934) observes that "the self is essentially a social structure" (p. 135), and that because "it arises in social experience…it is impossible to conceive of a self arising outside of a social experience" (p. 144). The theory of social construction of gender states that gender and gender identity are constructed by social interactions. Gender-based self-identity is greatly affected by one's social environment, including other people's attitudes and behaviors in a social context (Kelly, 1981). Lorber and Farrell (1991) believe that the structural arrangement of a society ought to be responsible to the stereotyped gender-based differences, where a biological division of male and female was used to explain their psychological, behavioral, and social differences.

Lindsey (2015) states that an individual has a number of ascribed statuses, such as gender, race, and social class, which were ranked in a social context. Being female, as a primary component of social classification, is accepted broadly as lower-ranked status than being male in most societies. Therefore, the socialized roles, as the socially expected behavior pattern connected with statuses, frame women's responsibilities and as being maternal, self-sacrificing, and domestic in nature (Lindsey, 2015). Lorber and Farrell (1991) also found that hegemonic social institutions—such as schools and media—not treat women and men equally. Women are devalued in the established social orders; consequently, gender becomes a determining factor with regard to individual's opportunities in education, work, and family.

In terms of how socialized definition of gender influence individuals' choices and attitudes, observational learning theory and social cognitive theory suggest that children often internalize other's behaviors and perceptions along with cognitive process, through observation and imitation. Bandura (1977; 1986) also claimed that human beings are also information processors, who often experience the mediational process to make decisions on whether or not encode their observations and imitate them. At the beginning stage, children observe both others' behavior and the consequence of the behavior. If they can remember these behaviors in certain occasions and believe they have relative capacities to finish the reproduction, they will face the next step—weighing the advantages and disadvantages of imitation. Based on their original observations, they will take the rewards and punishments they noticed into consideration. Children are more likely to be motivated to mimic the behavior that is rewarded regularly and widely and resist behavior that is frequently and continuously punished (Renzetti, Claire; Curran, Daniel; Maier, Shana, 2012). In reinforcement theory, this is also known as vicarious reinforcement.

Connected with science studies, it was also reported that women's gender-based role beliefs and identity were developed based on observing diverse groups of person and social world around them, including parents, teachers, peers, and media (Ho et al., 2008; Bandura, 1986). This means that the socialized gender norms regarding science subjects that are promoted by parents, peers, teachers and social media are easily delivered to children and shape their own self-identity.

In addition, the observed and imitated individuals are also called "models", influencing children's cognitive and mediational process. There are plenty of institutions/models at both the micro and macro level with regard to children, but they prefer to be convinced by the models that are similar as themselves (Bandura, 1986). Therefore, for female science education, peers' behaviors are expected to positively influence adolescence' academic performance in school (Dasgupta et al., 2015). Several studies have also provided insights into gender-matched models—such as female science teachers, successful female scientists, and well-educated mothers—demonstrating their effectiveness with respect to improving girls' motivations and interests in STEM fields (Riddell, 1989; Clandfield & Martell, 2014; Lockwood, 2006).

CHAPTER 3

Literature Review

Implicit Stereotypes for Girls and Chinese Traditional Values

Clandfield and Martell (2014) indicate that the one's entire social environment, including schools, media, and communities, imposes narrowed definitions of gender on both boys and girls. The socialized rules for girls are to do what they are told by teachers, to be nice, and to be responsible to family life. That contains two parts in the stereotypes for girls: one circles several specific criteria for what girls' 'appropriate' behaviors are, and the other emphases the importance of family roles for women. There is also a distorted but widespread interpretation of the theory: 'different brains' among boys and girls. It has been accepted that because of their different brain designs, male students have instinctive abilities in STEM fields and female excel in the social sciences. This kind of interpretation reinforced socialized gender norms. However, there are few differences in "basic cognitive, emotional and self-regulatory abilities" between males' and females' brains in their early age, specifically the primary and secondary school years (Eliot, 2011, p. 364).

Confucius and his philosophy shaped Chinese people's values, thoughts, and behaviors throughout the country's history (He, 1996). Chinese education, as a significant part of social agency, has been constructed and developed along with the influence of Confucius and his philosophy, so any educational issue should not be discussed without

Confucian philosophy (Qian, 2002). Under the influence of Confucian philosophy, many traditional values can also be found in Chinese education, such as “filial piety, respect for the elderly”, authority of teachers, and the emphasis of harmony (He, 1996, p. 3). In family life, children, no matter how old they are, should always show respect to the authority of their parents. In school, teachers always have the authorities and higher status. It is regarded as impolite behavior for students to challenge their teachers in most occasions and situations. Thus, teachers can deeply influence students’ learning as well as their selections of future career. Likewise, in social life, it is believed that a novice should respect the elder and experienced people. In addition, a person who can follow the authorities and majority is more likely to be appreciated.

Masculinized Science Curriculum and Women’s Underrepresentation

Students from different cultural or social backgrounds may differ in their learning styles and self-expressions (Bennett, 2007). However, historically, science, more precisely western science, was conceptualized as an androcentric and Eurocentric world where politically and socioeconomically vulnerable groups were marginalized (Harding & Longino, 1993). The nature of current science curriculum has been designed and developed from the western science, which focuses on the masculinized values and pedagogies. Alternative ways of knowing and Women’s way of knowing were often ignored in science community (Barton, 1998). For instance, STEM fields and subjects are always regarded as male and technology oriented, preferring mechanism, rationale and logic (Carnes & Bland, 2007; Roos & Gatta, 2009). It indicates that science is an objective and isolating field, requiring brilliance (Leslie, Cimpian, Meyer, & Freeland, 2015), instead of communal goals such as helping or working with others (Diekman, Brown, Johnston, & Clark, 2010). Thus, women's way of knowing, which concerns relationships and caring (Barton, 1998), is undervalued.

The underestimation of women's way of knowing can partly explain why the number of women increases in the biological science in recent years, but the gender gap in physical science, mathematics, and engineering remains noticeable (National Science Board, 2004). Several studies suggest that women are more willing to enter areas involving social interactions and connections, while men prefer physical objects and abstract concepts (Legewie & DiPrete, 2014). Murphy and Whitelegg (2006) also find that girls are more interested in how they could make connections with real life. In more abstract courses—such as physical science, mathematics, and engineering—there is more emphasis on statistical calculations, formation mechanisms, and theories. This is where girls have difficulty in making connections to their own values and life.

Since people are more likely to have interest and persist in activities where they feel confident and comfortable (Eccles, 1994), these conflicting or inconsistent values contribute to the lack of interest in science among female students. Girls will find it difficult to acquire the sense that they are able to fit in science activities and knowledge (Master et al., 2015). According to Master et al. (2015), stereotypical classroom environments will negatively affect girls' sense of belonging in an academic environment, which can be seen as a predictor of women's STEM interest. Even for female students who perform well in science work, their passion and persistence for STEM fades easily (Webb, Lubinski, & Benbow, 2007). Thus, girls have essentially "been brain washed into believing that they are not good in science" (Ker, Ekoja, & Anejo, 2010, p. 77).

Socialized personal traits—such as quietness or obedience, and traditional family roles for women—also set additional hurdles to girls' achievement in STEM fields. The expectation for a future family life or for family-flexible professions constrains young women's aspirations towards science and engineering fields (Frome, Alfeld, Eccles, & Barber, 2006) because these science-related realms are widely accepted to be more competitive and demanding. Moreover, expected personal traits for girls also hinder their academic development in STEM subjects as there is a conflict between girls' "appropriate" behaviors and the requirements of science. STEM requires that students are able not only to memorize formulas and theories written in textbooks, but also to critique previous findings and even challenge authority (Science for all Americans, 1990). Scientific inquiry, as the central part of science education, also requires students' questioning ability. However, girls are often educated to be quiet and conform to and accept whatever instruction teachers dictate. It also gives additional challenges to students whose cultural values do not encourage them to challenge their teachers in classrooms.

Girls under the Chinese education systems may feel greater pressures in science community because the major assessment criteria of a women's life used to be whether or not she could obey Chinese traditional virtues (Shen, 2001). As a result, practical experimental and scientific knowledge are often ignored or undervalued. Even in recent years, the traditional gender codes remain deeply rooted in science education, resulting in the lack of motivation among girls in science-related subjects. In STEM areas,

> girls exploited the assumption of helplessness by withdrawing and doing very little work at all. Girls, then, were able to use the assumption that females were quiet, helpless, emotional and very conscious of their appearance to avoid aspects of school that they found boring or difficult (Riddell, 1989, p. 92).

Moreover, when we review the design of science classrooms and pedagogies in China, it is still based on traditional or examination oriented curriculum. It ignores the process of how hypothesis was actually put forward and how it can connect with the outside world of classroom. It can give students neither confidence nor curiosity to work with science (Zhou, 2003).

Factors Contributing to the Formation of Gender-based Stereotypes

Secondary school stage is an important period of time for students' psychological development, regardless of gender/sex. Erikson (1968) notes that during this stage, students often encounter an identity crisis and start to pursue the cognitive meaning behind the answer of who they are and what they can do. The expectation and feedback that they receive and observe play vital roles in the process of their early self-identity. Thus, as Liu, Lou, and Shih (2014) suggest, children "observe, imitate, and use internal cognitive processes to learn the behaviors of others and can indirectly learn by observing others' behaviors or the consequences of others' behaviors" (p. 2).

In this context, girls have often been constrained and unmotivated in STEM fields and find it difficult to struggle in a hostile environment. Many issues in the education of female students in STEM courses can be explained through multiple dimensions of a society, involving the macro level of large-scale institutions and general cultural beliefs, as well as the micro level of interactional environments and individual experiences (Risman, 2004).

Influence of teachers. Through strategies founded on gender-based generalizations, teachers convey social constructs of gender to students (Riddell, 1989). For instance, although educators always emphasize the importance of equity in education, the reality is that within an academic context, boys and girls are often treated differently and teachers and parents have different expectations of them. This is referred to as the Pygmalion Effect, which refers to teachers' expectations and how they affect student success and future development (Clandfield & Martell, 2014). Teachers may reinforce traditional gender codes both consciously and unconsciously.

Through observation of many classes, Ebbutt (1981) believed that teachers sometimes have to spend more time and pay more attention to boys to guarantee the normal order in class because boys are believed to have more problems in self-discipline. Riddell (1989) found that most comments on girls, from both male and female teachers, are associated with adjectives such as “mature”, “quiet”, “hardworking”, and “stable”. However, these assigned impressions are far removed from the positive evaluations. Walden and Walkerdine (1985) notice the same evaluations. For example, they note that girls are seen as naturally more diligent, but it seems implied that girls have no choice to behave better in order to bridge their intellectual inferiority in high level problem-solving ability and creativity. Girls are likewise often expected to do less creative work. This is outlined by Riddell (1989):

> When it’s just a routine approach—you know, you do one on the board and they do the others with just a few small variations—then the girls, by virtue of following carefully what you’ve done, and taking it down neatly and reading about it and so on, they do better. I think the boys, if you wanted to devise another way of doing the problem, other than the one you’ve shown them, I think I would plump for a boy finding that (p. 185).

Thus, girls are seem as simply being capable of effective mimicry, while boys are viewed as innovators.

Acker and Zaher (1996 & 1993) state that in science courses or activities, teachers often try to attract boys’ attention through eye contact or gestures and give them more opportunities during class discussion. This kind of teaching strategy is accepted by most of teachers, not only because that can keep boys’ attention away from distractions, but also because teachers expects boys to respond more quickly and with more creativity and imagination. Riddell (1989) asserts that sometimes the masculine bias is not noticeable and difficult to discover. For example, he observes that "science lessons would often draw on examples from boys' experience, and deal with subjects with which boys were likely to be familiar such as electricity and magnetism" (p. 188). Higher levels of interaction with teachers and more expectations from teachers situates boys in an advantage where they are encouraged and motivated to perform more actively in science classes and get more involved in discussions.

Students likewise bring different gendered presumptions of their own capability, interested fields, or appropriate behaviors to school (Cech, 2013; Charles & Bradley, 2009). This means that for some students, their gender identities do not conform to what teachers expect of them. However, in the context of China, where respect for teachers is emphasized, they are less likely to challenge teachers' authority. Consequently, it is easier for Chinese teachers to reinforce socialized gender norms.

Influence of labor market. Knight (2016) states there is an unavoidable fact that, except from personal interest and characteristics, the chance of getting a job always plays an important role in the selection of the study direction. Most parents, educators, and girls themselves take future opportunities into account when making educational choices and investments (Schultz, 1993). This idea has been supported by several studies. For example, Guiso, Monte, Sapienza, and Zingales (2008) found that girls outnumbered boys in STEM courses in some countries, such as Iceland, where there is comparatively greater gender equality in economic participation and career opportunities. Many studies also indicate that girls' mathematics' test scores are closely related to women's status in the local labor force (Riegle-Crumb & Moore, 2014). Generally speaking, women face more discrimination at work, have less job opportunities, and receive lower salaries (Shu, 2004). The fact, that women with a STEM degree have fewer opportunities than their male counterparts in STEM occupations reinforces implicit gender stereotypes and results in gender disparity in science direction.

Figure 1 illustrates that the gender gap in employment in China is noticeable. Although state employment increased gradually after the year of 2005, the velocity of ascension for female employment was lower than that of male employment from 2005 to 2010. Knight (2016) explains after Top-down reforms were implemented "to initiate a shift from a command to a market economy, with the removal of lifetime employment guarantees, state-owned enterprise (SOE) privatization, and liberalization policies" (p. 215), the Chinese labor market has experienced huge changes in structure since 1979 (Diekman, Brown, Johnston, & Clark, 2009). These structural shifts, where the Chinese market was transforming to a market-oriented structure, contributed to economic uncertainty, a decrease in employment, and a widening of gender occupational segregation (Knight, 2016). Affected by gender status beliefs, male workers have often been characterized as more competent and purposeful than female workers (Ridgeway, 1997). That resulted in the exclusion of 'expendable workers', which often include less educated and married women, as enterprises struggled to survive in the harsh market by controlling costs to improve productivities (Ding, Dong, & Li, 2009).

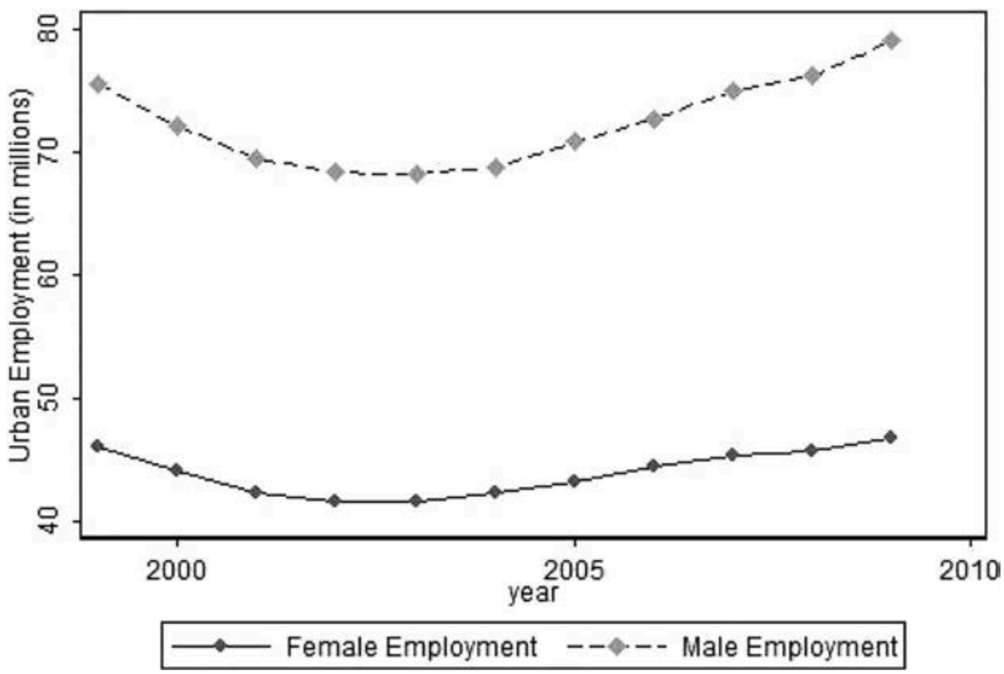

Figure 1. Annual Gendered Employment in China (1999 to 2009). Note: Urban employment figures include only formal employees working in an urban area at year's end (Knight, 2016, p. 216).

In addition, the retirement policy at that time demanded women to retire from their workplace at the age of forty-five, which was much earlier than the male retirement age—fifty years old. That is believed to have widened the existing gender gap and increased the gender inequality in employment (Ding et al., 2009). Liu (2007) also mentions that due to the retirement policy, female and male workers received differential treatments in labor market, along with the reemergence of male-breadwinner ideology. Approximately 60% of women faced layoffs during that period and found difficulty in re-entering workplace.

For career opportunities and selections, gender has always been a critical factor (Livingstone, Pollock, & Raykov, 2014). Table 1 demonstrates that there has always been a hierarchy among the different career fields and that gender-based occupational segregation exists in China's labor market. Women's career choices were narrowed into a small scale, often in light industries—such as textiles, retail, entertainment, finance, and education fields—where the work was regarded as temporary and less challenging and consequently offered lower wages (Knight, 2016). In contrast, their male counterparts entered major industries or STEM fields, like construction, transportation, or scientific research, and male's work was more likely to be valued and appreciated (Liu, 2007). Thus, as Knight (2016) concludes, "The separation of women and men in Chinese urban labor markets became more extensive over this time frame" (p. 218).

TABLE 1
Female employment as a proportion of total employment in urban China

Sector	*(% in 1998)*	*(% in 2010)*
Textile & Apparel Manufacturing	NA	68.7
Sanitation, Social Security & Social Welfare	51.4	60.0
Retail & Trade	51.7	55.1
Accommodation & Restaurants	44.6	54.1
Finance	NA	50.6
Education	43.5	50.3
Entertainment	37.5	49.3
Banking	42.0	47.4
Average	37.9	38.0
Real Estate	36.0	34.2
Scientific Research	33.8	31.5
Party Management & Organization	21.3	24.2
Traffic and Transportation	27.2	26.8
Mining	25.7	18.8
Architecture	NA	17.1
Construction	18.5	13.1

Table 1. Notes: Data obtained from the China Labor Statistical Yearbook, a publication of National Bureau of Statistics of China (1999; 2011). NA indicates that the data was not available in the relevant yearbook. Urban employment figures include only formal employees working in an urban area at years' end (Knight, 2016, p. 218).

Studies have showed that there is a strong connection between socialized gender stereotypes involving gender status beliefs and current occupational separation in labor market. The gender gap in the current career market will "increase with the degree of legitimacy of gender status beliefs in institutional contexts" (Tian & Liu, 2017, p. 30). These pervasive beliefs can also work as underlying mechanisms for gender inequality in the labor market (Acker, 2006; Ridgeway, 1997).

Influence of parents or guardians. Stereotyped gender norms appear and develop much earlier than high school years. By the age of five, it can be found that girls and boys construct their own original gender-based identity (Martin & Ruble, 2004). For instance, the differential categories of toys for girls and boys were quickly created and accepted by children according to how they think they 'should' behave (Raag & Rackliff, 1998). Girls select popular 'girl' toys because they know they are expected to play with dish sets and baby dolls (Raag & Rackliff, 1998). Manufacturers and retailers also believe that if toys were labelled as the most popular girl's toys or the most popular boy's toys, parents are more likely to buy them because that labels are helpful for parents seeking to determine whether the toys are gender 'appropriate' (Freeman, 2007). This marketing strategy was put into practice, because it has been proven to be successful in many cases. For example, 'Dreamweaver' Bikes and 'Top Gun' Bikes were the best sellers for girls and boys respectively (Daniel, 1999). Although most parents' responses in the research indicated that they follow the same standards of behavior for their sons and daughters, the reality is that a large number of parents persist in adopting traditionally gender-based values when deciding what is appropriate for girls, and parents can provide little support in terms of cross-gender choices (Freeman, 2007). This gender segregation of toys has situated young children into a socialized gender norm.

Women's or girl's education has always been an issue in China. Influenced by Confucian educational philosophy, women's virtues are often closely tied with "good wives and wise mothers" (Jia & Ma, 2015). This has contributed to the parents' general preference for investment on boy's education, especially in rural parts of China. Women are traditionally expected and forced to provide various sorts of support for their in-laws' household after marriage; thus, parents are unwilling to invest in girls' education as they cannot get a return from their investments (Fan, 2003). Thus, women's human capital and academic attainment are viewed as inferior to their male counterparts (National Bureau of Statistics of China, 2010). Recently, although some parents' educational aspirations and exceptions for their daughters has changed to attain university degree, these gender-based criteria and assessments, like what a girl 'should' do, have been internalized into their beliefs and values. Chinese parents often regard advanced diplomas as a necessary premise for a decent job and income. In other words, they think the final purpose of universities or post-secondary education is to prepare students to work. This is why parents may be unwilling to support students' further education when they think the current credentials are sufficient to get a quality job, especially for girls who, in their mind, should seek what they view as suitable and that do not place too many demands or too much pressure so that they can spend more time taking care of their families. In addition, since girls' capabilities and development in science areas are underrated by their own parents (Ceci, Williams, & Barnett, 2009), it seems unlikely to expect parents to be able to give instructive support and advise in STEM fields.

Findings indicate that parents' educational and financial background also influence students' participation in STEM fields (Fan, 2003). For example, working-class female students who would like to pursue higher education or work in STEM fields have certain realities to consider—such as financial support/costs, job opportunities, time, and future income—because they may face more pressure from their families. Given women's lower status and reduced opportunities in STEM-related jobs, working-class girls or those from socioeconomically disadvantaged families are less likely to consider studies STEM fields. In some extreme cases, parents even force them to make a choice that they deem as beneficial for the whole family. Affected by Chinese traditional social values, children, especially girls, are expected to devote themselves to the welfare of their families, even at the cost of their own social identity (Liu, 1998).

Influence of peers. Dasgupta et al. (2015) studied the effectiveness of female peers in small work groups with regard to improving women's motivation in engineering. They state that peers' influence is distinguished from other factors responsible for gender disparity in STEM fields: "Unlike experts who are successful and advanced relative to young students, peers are at the same stage of development, making their social influence psychologically different… Peers may be more effective because of their greater similarity to young students" (p. 4989). After creating microenvironments/small groups with varied proportions of women, their study found that women's schooling experiences are positively influenced when they are in groups with a female majority. In addition, women feel less threatened and less challenged in female-majority groups.

Lord, Saenz, and Sherman (1985) also mention that women's learning process is likely hindered when they become the lone female in an all-male or male-dominated group. This solo status decreases individuals' confidence, motivation, and sense of belonging in certain areas (Sekaquaptewa & Thompson, 2002), and that negative decrease will foster a sense of isolation and dissatisfaction with the task they are working on (Niemann, Dovidio, & Murphy, 1998). Women often develop lower performance expectancies prior to starting the tasks and express more desire to change the gender composition in male-majority groups, while men show less inclination if they are the only male member in a group (Sekaquaptewa & Thompson, 2003). Murphy, Steele, and Gross (2007) also note that women are reluctant or more hesitant to enter environments where they are gender-based minority. The negative influence of solo status is particularly powerful for historically disadvantaged groups in traditionally male-dominated or masculine fields, such as STEM fields, where women's abilities are underestimated (Dasgupta et al., 2015).

In addition, interruptions from boys in the classroom can be one of the reasons why girls are less interested and poorly perform in STEM subjects. Greig (2011) supports this finding, noting that after carrying out single-gender reform in Flintridge Elementary school, girls enjoyed classes more than in coeducation and were more likely to be motivated in the classes of mathematics and science, without the distraction from noisy and disturbing behaviors of boys. In New Zealand, advantages of single-sex education were found for both males and females (Woodward, Fergusson, & Horwood, 1999). In the context of Australia, Smyth (2010) indicates that girls were more likely to perform better in the single-sex settings, especially in the area of mathematics and science. Spielhofer, Benton, and Schagen (2004) found that for girls, lower ability groups saw greater progress in a wide range of subjects in single-sex schools of England. In the American education system, the positive effect of single gender settings has also been shown for girls, especially for low socio-economic status and ethnic minority students (Riordan, 2002).

CHAPTER 4

Methodology

Research Design

The purpose of this study is to investigate how Chinese female students make decisions regarding their academic path in high school and why less girls choose STEM studies. This research has employed a qualitative research design with a focus on a multiple case studies to open dialogues with female students in the context of China.

Van den Hoonaard (2015) claims that qualitative study allows participants to define what is central and crucial in their experience using their own terms. It can help researchers gain a deeper understanding of the participants' attitudes, viewpoints, and behavior patterns (Kothari, 2002). In addition, Isaack and Michael (1981) and Yin (1994) state that case studies can be used to explore a contemporary phenomenon in depth and in detail by examining a single case or multiple cases. Given the goal of the current research is to explore how Chinese high school students make decisions between the two education directions—Arts (social sciences) and Sciences—and discover the factors contributing to the gender disparity in STEM subjects, a multiple-case study design was chosen for the current research.

Research Site and Participant Recruitment

This study was conducted in a middle-size city of Hebei province—Tangshan. Hebei province is one of the large provinces where approximately 500 thousand candidates take the university entrance examination every year. Tangshan has large diversity and significant resources and is regarded as the important commercial heart of Hebei province. Hong When High School and No. 1 High school of Kai Luan were chosen for this study as studied cases because some of the teachers in the two high schools were the researcher's high school teachers about ten years ago, there were existing links between the researcher and the two high schools. These teachers also mentioned that there was a marked gender disparity between social sciences and sciences in both schools. This research chose six female high school students, who had been enrolled in social sciences direction after Grade 11. All of these selected participants were from the two Chinese high schools. Permission from school teachers and principals was secured before conducting the research. A recruitment letter (Appendix A) was made available to all potential participants from these two schools.

Data Collection

The one-on-one interviews were conducted using a semi-structured question guide (Appendix B). Interviews were preferred in this study because they allow the capability to get close and provide direct insights into participants' perceptions and personal feelings through the conversation between researchers and respondents (May, 1998). Silverman

(1993) suggests that most people live in an interview life, which means that few people have never experienced interviews in daily life. However, these interviews are often standardized interview, with close-ended questions or force-choice questions to collect structured and relatively cheap information (Van den Hoonaard, 2015). Therefore, semi-structured in-depth interview was employed in this study to discover any unexpected data from the participants' perspectives. The interview guide was designed as the general structure of the whole interview, but more flexibility was given to the respondents, especially when interviewees showed more interest in a specific direction or question. In addition, Bryman (2004) states that in-depth interviews can more easily elicit rich information in feminist research because they allow researchers to pay much more attention on interviewees' verbal and facial reactions.

The interview questions were developed based on existing literature and theoretical framework of this study. Questions focused on several aspects, such as background information of students, self-expectation, career designs, opinions about gender-based norms, previous learning experience in science classes, and interaction with peers, teachers and parents.

A consent form (Appendix C), a letter to parents/guardians (Appendix D), and an information letter (Appendix E) were sent to the six participants after they contacted the researcher. After about one week, the researcher contacted them again to arrange the interview. An audio recorder was employed during the process of interviewing. During the interviews, researcher also took field notes to capture the missing data in audio recordings, such as body gestures and facial expressions and to write down my ideas/comments on the interview process. After finishing the interview, the researcher provided every participant a notebook as a small token. The interviews for the six participants lasted from about half hour to one hour.

Data was transcribed, and translated to English, and the researcher deleted any information that might identify participants' identifications. The transcriptions were returned to participants within a week of the interview for the purpose of member-checking, so that they could have opportunities to delete, add, or clarify their ideas or descriptions. Letters from A to F were assigned to the six participants to protect participants' identifications.

Among the six participants, students A, B, C, and D were from Hong When High School, while students E and F from No.1 High school. Only student E is an art-specialized student, and she will be required to attend both the university entrance examination and the specialized art examination. It also means that even if she gets a lower score in university entrance examination than other candidates, she still has an additional chance to narrow the score gap in the specialized art examination and enter universities relying on her painting or drawing skills.

Students B, E and F lived in the urban areas, while students A, C, and D were in the countryside of the city. None of the parents of the participants experienced post-secondary education. Parents of students A and C ended up a middle school diploma as their highest level of education.

Data Analysis

The researcher analyzed the interview-based data by reading each transcription and field note several times, word by word, to capture any possible deeper meaning from participants. During the process of coding, the researcher labelled all of key points, topics, and detailed concepts that emerged from the data. Then all coded data was classified and assembled into several main themes.

After reviewing all data, the researcher highlighted several useful and significant codes and then made connections to these concepts from the previous literature and from the interview-based data itself. In addition, the researcher also paid more attention to some words and phrases, which participants frequently mentioned and used. Several sub-themes were identified finally and reorganized according to the main themes.

CHAPTER 5

Results

To enhance the understanding of female underrepresentation in STEM fields and eliminate the possible inhibitions for girls in science areas and disciplines, six female high school students who had selected social sciences direction after Grade 11 were interviewed in this study. The findings from in-depth interviews were analyzed and classified into five themes: science curriculum, the influence of teachers, the influence of labor market, the influence of parents, and the influence of peers.

Science Curriculum

Lack of Confidence in Sciences Direction

Students A, C, and E's science grades were much lower than their grades of social science subjects. Their confidence in science leaning were negatively affected by their poor academic performance in science examinations. Student C shared her experience:

> When I was in my middle school, it was the first time that I was exposed to and started to learn these science subjects, like physics, chemistry or biology. Once you were frustrated in the examinations of these subjects, you probably lost confidence and gradually gave up them. Since at that time, we had nine required courses…you know, I needed to pay more attention to the subjects that I was able to improve.

Student C gradually lost her confidence in science learning when she became frustrated and depressed after failing to secure the grade she hoped for in several science exams.

Students B, D and F had science grades that were quite close to the grades they got in social science disciplines; however, during the interviews, they still thought that they could not do well in science direction. Student B said,

> I am afraid that I cannot handle the advanced level of science learning in the future…including comprehending the logic of some theories or calculating data in math.

Student F thought she was not competent in science subjects, and student D mentioned that her ideal career position was teacher, though she never imagined being a science teacher. She said,

> Actually, I like mathematics and my math grades are good as well, but…I feel that I am not capable to choose math as my major in university. My mind and intelligence cannot support me in the future study if my major is math.

Regardless of how they performed in science disciplines, these girls intended to underestimate their capacities and potentials in science areas.

In addition, students A and B thought that social science tests were easier than science tests. This remains true despite the fact that after experiencing one-year study in social science classes they now view the social sciences are more challenging than they first anticipated. Student A shared her opinions:

> I thought, in Grade 11, that even now I could not understand all of what teachers taught in science classes sometimes, let alone in future science learning which would include more complicated calculations or formulas. For arts subjects, they were more subjective, and at least I could get some points and marks in examinations…But, now, I think my original thought probably wrong. The arts subject exams become increasingly difficulty.

Student B also mentioned that the difficulty of science learning and the possibility of getting higher marks in exams influenced her decision:

> At that time, one of my senior schoolmate in Grade 12 told me the arts subjects were quite easy to get marks. For multiple choices, it is quick to identify the right answers. For short/long answer questions, even though you may not be clear about the points of these questions, you can still get lots of marks as long as you write something on the test paper… however, now I find that the social sciences subjects are not as simple as she told me …quite hard to get to the points of the questions and get the marks.

In Grade 11, when students A and B were required to make a choice between science and social science stream, both believed that the future science exams and learning would be more difficult and felt more confident for future social science exams. Thus, perceived difficult is a determining factor with regard to students' academic decisions.

Decreased Interest in Science Subjects

In addition to the lack of confidence, interviewed students also indicated that current science learning in high school years was boring and that most scientific knowledge taught in class was meaningless. Student B said that in her middle school, her chemistry teacher was professional at enlivening the class atmosphere: "He often sacrificed two classes to enable each of us to conduct experiments in person, and he always used interesting presentations or videos in class." Therefore, she used to enjoy chemistry learning in her middle school, but chemistry now was less appealing for her in high school. Student C also mentioned the similar change:

> In my primary school, we only had one integrated class, called science. Science teachers lead us to do some artificial models or small experiments related to natural phenomenon…quite interesting, even now I can remember some of the experiments. But later in middle school and high school, there were too much complicated theories or knowledge. I felt that I understood in class, but still confused in later exercising and got low marks in following tests.

Student D said that most of impressive classes happened in her primary school and middle school. In primary science class, two students "shared one microscope to observe cell walls of plant." For physics, in the first class of Grade 9, "the teacher taught everybody what the intensity of pressure was by using lots of experiment tools and examples in daily life." However, "in high school, with the increased study pressure, most time in class was spent in doing exercise for examinations."

Student E also complained that the routine for science learning was boring in high school. She said that "teachers required students to prepare for the following class, just scanning the knowledge in the textbooks. Then, they would teach these theories or formulas or answer questions of previous exercises. After class, we would do plenty of relative exercises again." Student E was interested in doing lab activities, but "only experiments that probably appear in university entrance examination may be conducted by teachers in front of the whole students." Student E assumed that science teachers arranged their classes this way because of the competition stress of university entrance examination: lots of high schools would rush to end all of teaching tasks required in curriculum and textbooks before entering Grade 12 so that these students have enough time to rehearse exam tips or skills. Student B also agreed that the university entrance examination did not focus on hands-on abilities of experiments or practical applications, and that is why there are always plenty of exercises on calculations or formulas for high school science learning.

Science-related Activities in School

China has a number of national competitions related to science, such as the physics knowledge Olympics and physical inventions competition; however, female students were often discouraged from participating in them. The physics knowledge Olympics is a paper-based test consisting of a variety of advanced-level calculations. Local winners go onto attend province-wide physics Olympics, and then a national competition. Likewise, the physical inventions competition was designed for talented students who were able to invent robots or small device in the fields of physics. These contests are an effective way to expose young students to and encourage them to engage in science. However, though students E and F knew about school activities related to these events, they never participated in them. Student F explained that she could not participate in these events because they required head teachers' permission, and because she did not excel in science, she was unlikely to secure their consent. Alternately, Student E was neither interested in nor competent enough to take part in these science-related activities.

Unlike students E and F, students A, B, C, and D did not recall any science extracurricular activities in school. Student A and B said even if there were lots of activities in science subjects, they would likely be unwilling to participate since it did not make sense to attend these science activities if they did not excel as such things. Student D also considered that the limited time and heavy study tasks for high school students would discourage them to being involved in such activities.

However, student E expected that school could provide students with more opportunities to be exposed to the stories of scientists and their experience in science learning, or some scientific documentaries/films. She believed that these activities could trigger students' curiosity in science fields or subjects.

Influence of Teachers

Direct Advice

With the exception of student E, all the participants mentioned that their teachers gave them some general advice about the selection between social sciences and science. However, teachers only mentioned some possible jobs in the two separate directions. For instance, Student A said,

> My teacher, who was in charge of the whole class, did not talk much about the selection or the potential opportunities for future career in details. Actually, I cannot remember what she said……I felt quite confused during that time.

However, the advice offered by student C’s teacher impacted her decision-making process. She thought that her teachers, especially the teacher in charge of the class, could understand her better than parents and were able to provide more academic suggestions. Her grade-10 head teacher, who also taught Chinese, told her that social sciences direction was more suitable for her given that she had better performance in social science subjects. That was one of the reasons why she chose the current direction.

Relationship with Teachers

Students B, C, D, and E all mentioned that teachers had a great impact on students’ academic choices, especially when students had positive relationships or communications with their teachers. Students were more likely to perform better in the subjects taught by their favorite teachers, and made more progress in these subjects. The participants only mentioned their teachers in social science subjects, such as Chinese, Politics, or History, when they were asked to answer "How teachers influenced your academic/career choices?" Students A and F did not think that their respective teachers significantly influenced them, and they also felt that there was no close relationship between them and any teachers they met.

Both Students B and C attributed their current decision to the role model of teachers. Several times during the interview, student B told the researcher how important her teachers were, especially her Chinese and politics teachers. In the context of China, with respect to teachers' authority, the traditional or common relationships between students and teachers are strained, but student B felt relaxed in her past experience with Chinese teachers:

> All of the Chinese teachers I met, from my elementary to my senior high school, were excellent teachers, and I liked them so much that the relationship between us was not just students-teachers but more liked friendships. I was always the assistant and representative of Chinese lesson. In my middle school, the head teacher of my classroom taught mathematics. He always criticized me and my bad scores in math examinations. When at that time, my Chinese teacher would put in a good word for me, and she often took me as a good example in front of the whole class…when I came to my high school years, the head teacher of class became the Chinese teacher. I thought our personalities were so matched that I even chatted with her after classes were done. I could say anything about my

> confusions and troubles with her. I told my mom that I hoped I could stay in her class all the time.

In addition to these Chinese teachers, the politics teachers also left an impression on student B as her interactions with the teacher made her feel valued:

> I told my friend yesterday “I miss our our politics teacher in our middle school so much”, and she could not understand me because our politics teacher was a little bit strict. In her class time, no one dared to sleep…but, actually, she was special to me, you know…I felt that she paid more attention to me. I interacted frequently with her in class and she always asked me to answer questions as long as I raised my hand.

Student B also pointed out that one of the direct reasons why she did not want to go the sciences direction was her Chinese teacher, the head teacher of the class. If she chose sciences direction, she would be assigned to another classroom and that meant her Chinese teacher could not teach her any more. The active connection with teachers also influenced her future career choices:

> Although my parents advised me to be a nurse in future, or to pursue a career related to medicine field, I still wanted to be a Chinese teacher. I believe that I will enjoy the feeling when standing on the classroom platform in front of the whole class and teaching them… I will become the same kind of teacher as my Chinese teachers or politics teachers.

Students D and E said that their interest in and passion for certain subjects may be dependent on whether or not they like the teacher. Student E offered her thoughts:

> It really depends on teachers. If I like the teacher, I will definitely keep what she/he said in mind and understand knowledge better. For the teachers I don't like, I cannot remember and recall what they told during class.

Interactions with Teachers in Science Classes

During interviews, students C, D, and F noted that a small number of students in science classes were always ignored by teachers. Student F said, "I am the kind of quiet person in science class, and I thought teachers seldom noticed me or tried to interact with me in class." Student C thought it was understandable that teachers tended to pay more attention to students who were more active in class:

> Teachers also need reflections from students. For example, when teachers asked "Do you understand?'' some students who often performed actively in class might answer "yes" or "no". Teachers would regard these students' responses as the representative of the whole class since that was the only reflection they received. There are too many students in a classroom, so actually teachers cannot notice these "quiet" students.

Student C also mentioned some outgoing girls actively engaged in science classes, but compared with the boys in the class, most girls were quiet and simply listened during class.

In addition, student D observed that two types of students were more likely to draw teachers' attentions in science classes: students who performed well and students who were regarded as 'troublemakers'. She said,

> Teachers often expected or directly asked students who performed well to answer questions. 'Troublemakers' were also appointed to answer questions when teachers found that they attempted to chat with other classmates or slept during class.

Thus, when students' behaviors stood out in class, teachers were more likely to engaged with such students, and because the docility that females were socialized to practiced did not garner teachers' attention, teacher were less likely to engage with them.

Gender Ratio of Science Teachers

Students E and F said in their memory about science teachers, there were more male teachers than female in science faculty. However, students A, B, C, and D all observed that there were more female teachers in their high school. This was exemplified by C: "the number of male teachers is much less in high schools… in terms of the job—teachers—females also show more interest than males." Actually, all of them were less concerned about the gender of science teachers.

Influence of Labor Market

Job Opportunities

When they chose their academic/career directions during high schools, most participants also considered the opportunities they could access in future career of local labor market. Student D said she preferred majoring in Chinese because her sister told her that would provide her with more, well-paying, career opportunities and internships. Student F had several hobbies, including creating short animation and making coffee, but she thought these were only romantic ideas because these types of job did not traditionally pay well. She also believed that it was difficult for girls "to find a job in these fields." Student C also shared what she viewed as ideal jobs:

> Not lawyer, though I am fond of some TV programs related to law… The national judicial examination is too hard to get the certification. To be a teacher is good, but again it is hard to get this job. I think the ideal job is a civil servant. Not too much work pressure, and doesn't require the Master degree.

Though she expressed an interest to work in law or secure a position in education, she was concerned that they would be difficult to enter.

Both students A and D mentioned the impact of mass media on their impression of certain jobs. Student A planned to go into marketing since she noticed that a lot of female candidates in a TV program wanted to enter this profession. The description and introduction of the job requirements were also attractive for her. Student D said she was not interested in working in hospital because

> Lots of news about the patient-doctor disputes in TV and Weibo [one of the most popular social media platforms in China] …I still prefer these jobs like Chinese teachers, which are more stable.

The employment information they received from mass media influenced their personal development planning.

University Diploma

All students showed strong aspiration to go to universities even though most of them had not considered their future majors seriously. For example, student F was confused about what she could do in the future, but she was sure that she must go to university. In terms of the necessity of university diploma, all agreed that securing a university education was critical to them. Student D expressed her opinion:

> If you want to be successful in China… you need to focus on your academic study. From a Chinese point of view, getting diplomas or certifications from prestigious universities is the only way that you can get a good job and change your current life… Actually, they really ignore the information about colleges and skilled workers.

She thought that in Chinese job market, university diploma was still valued.

Therefore, one of the most important standards for the participants was whether or not their academic choices between social sciences and sciences direction would help them to enter universities. Students A and C chose social sciences direction because their scores were much higher in social science disciplines. Student E chose to be an art-specialized student and entered social sciences direction in Grade 11, also because she considered the advantages she could get in university entrance exam:

> I chose to learn arts and become an art-specialized student at the beginning of my high school years. Art-specialized students can add the scores of the specialized art examination to the real scores they get in the national university entrance examination… I chose the social sciences direction because I would get a higher grade in these social science subjects. In Grade 12, I will have arts training in Beijing and several additional school-scale arts exams. All of the art-specialized students need to attend such training and exams. So when we come back to school, we will only have three months before the university entrance examination. For the science related subjects, you cannot improve your scores in only three months. But for social sciences… [students] only need to memorize some knowledge by rote.

Student E realized that art-specialized students could take advantage of the government policy in the university entrance exam. However, this kind of advantage also means students probably need to consider the cost of opting out of the sciences stream.

Influence of Parents or Guardians

Parents or Guardians' Expectations on Academic Path

Except student E, all the participants said that their parents offered little advice and guidance on the two academic directions. Students A and B told the researcher that they did not think their parents had any direct influence on their academic choice. Student C explained that most parents were not able to understand what students need for their future academic studies since high school students spent more time in school with teachers and classmates than they do with parents. Student E's father told her both of the two directions were acceptable, but her mother strongly recommended that she chose the social sciences direction, citing considerations for entrance into university.

Although limited attention was paid on the choices between social sciences and sciences, all the participants' parents clearly suggested that their daughters ought to go to universities. Student A said the only requirement of their parents for her was to earn a bachelor's degree. For student B, 'studying hard' and 'university' were inevitable topics in daily conversations between her and her parents. Student D thought that parents' past experience resulted in their strong expectations regarding universities:

> Parents always believe in the old fact that going to universities is the only way to change life. A student must study hard, otherwise she/he will feel regretful in the future…you know, they cannot accept the idea that the students who choose colleges or technical schools can also develop quite well in future… Because there were only

a few opportunities to enter a university during my parents' generation, they may impose their desire to go to university onto the next generation.

Student C also spoke about her mother, who had lost the opportunity to go to university because she was born in a rural village where the traditional male-dominated conceptions were deeply rooted. Thus, her younger brothers took precedent. In addition, student F's mother has a middle school degree, and her mother said that there were too many children in a family at that time. A family could not afford all kids' schooling, even though student F's mothers' performance in school and examinations was outstanding.

Parents or Guardians' Suggestions about Career Path.

All the participants stated that their parents did give them some suggestions about future career path. In the view of students' parents, the definition of ideal jobs for girls was always connected with the word 'stable'. One of the criteria was whether or not the job could offer an office instead of requiring arduous manual work in factories or outside. Some other criteria—such as easy access to jobs, less work pressure and stable salary—were also taken into consideration. Nurses, teachers, and civil servants were regarded as comparatively stable jobs by parents.

Although student E, as an art-specialized student, needs to select art-related majors in university, her future career plan was still to be a teacher, specifically an arts teacher. Unlike the participants who spoke with their parents, student A preferred to talk with her grandmother when she felt confused. With regard to her future career, student A's grandmother always recommended she to pursue stable jobs. Student A recounted her grandmother's observations:

> When talking about the word 'career' or 'future', for a girl, many people hope… or the first thing that comes into their mind is to be a teacher or nurse, some stable jobs like these. They cannot figure out other types of jobs in mind.

Student C said "my preferred jobs are low-pressured, stable, and well-paid positions, like civil servants," and she did not think parents provided with her any useful advice or greatly affected her. However, based on her own description and memory, it was her parents who firstly mentioned the job position—civil servants. Her parents considered civil servants as one type of "stable jobs," as "being a civil servant, in China, is less demanding and its salary is above the average level." All characters of student C's dreamed jobs were in accord with parents' descriptions of civil servants. It seems that parents did affect student C's definitions about what the ideal jobs were. This was consistent with student B's experiences. She said that her career plan to become a Chinese teachers was primarily influenced by her teachers and that she would not follow parents' arrangement to be a nurse or doctor as she was a little bit rebellious. However, her opinion about ideal jobs was quite compatible with those of her parents:

> Subjects in social sciences direction are more suitable for girls… you know, girls, they are quiet…and need some stable jobs, like teachers or nurses. After all, it is better for girls to have a stable life and harmonious family.

Participants' Perception of Gender

All of the participants stated that boys and girls differed in several aspects, including personal characteristics. Most students believed that these gender-based differences in personal traits between girls and boys were not inborn and fixed, but developed and changeable. Only student A clearly articulated that "boys are inborn to be more active and energetic, while girls like being quiet." Student B insisted that the educational environment, especially parenting and where kids grew up, shaped what the characteristics they adopted. She shared her experience about changes in personalities:

> I was quiet and unobtrusive when I was a kid. The change owed to my parents. As businesspersons, they often needed to travel to different provinces and attended diverse occasions. Sometimes they would take me. That is why, with age, I became brave enough to speak out about my ideas with any person in any situation.

Student C also believed that although girls were often regarded as 'quiet' or 'shy' while boys were regarded as 'naughty' or 'active', their personal traits developed with age and were affected by their environment. Student D's parents and elder relatives always directly told her what behaviors were and were not acceptable for a girl. She said that:

> Girls should not be too aggressive and domineering… especially in family life. Parents or the elder generation often told me "A girl ought to behave like a girl, gently, quietly and stably".

Her family environment created several traditionally gender-based rules and standards for her and attempted to fit her in socialized definitions of gender.

Influence of Peers

Friends/classmates' Choices

Although female high school students preferred to spend leisure time with their classmates and friends, most of them believed that in terms of the academic streaming between social sciences and sciences direction, peers' influence was limited. This was reflected by student B's thoughts on peer influence:

> Compared with my parents, I like chatting with my friends. You know… you cannot talk too much with parents. Conversations with parents always increase your stress. They always tell you that "you need to study harder", something like that, because of generation gap… My best friend used to be one of my classmates. I always talked with her about future plan or university life, or personal secrets. But, we still chose to different directions in Grade 11.

Student D also mentioned that her best friend went to sciences directions. Affected by that, she was indecisive at the beginning, but finally still made her own choice to focus on social sciences.

Compared with other influencing factors, peers' impact seems less crucial to female high school students' academic decision. However, peers are more likely to affect students' hobbies or interests in certain areas. For instance, student A mentioned that her interest in French horn owed to her friends' recommendation. For student D, her entertainment activities were closely associated with her friends. Almost all of her favorite books, magazines, or TV programs were recommended by her friends or classmates.

For student E, peers are more influential on her academic decision. She said that almost all of other art-specialized students chose social sciences direction and she did not want to be the solo science student among these art-specialized students.

Participants' Perception of Gender-based Differences in sciences direction

To some degree, there was a concurrence of gender-based stereotypes in science fields. Students C, D, and E thought that females and males differed by nature with regard to intelligence and personal preferences. Student D mentioned that it was comparatively easier for boys, especially in high school, to improve grades in science subjects, than their female classmates. Student E also believed that in science areas, boys' intelligence was superior as their thinking was more active, while girls were better at social activities.

Students A, B, and F did not totally agree with the statement that females are good at social science by nature and that males do much better in STEM-related jobs, but they indicated that individual characteristics and mindset indeed differed from genders. They thought that boys were more suitable to learn science subjects because they were better at logical thinking and enjoyed discussion over memorizing various knowledge quietly.

It is interesting that students' perceptions about the existing differences between boys and girls in science fields were constructed by their own observation of their classmates. Peers' influence reinforced some gender-based stereotypes in science learning. For example, student E said that in her memory, boys always did better in science subjects. Student C shared a similar story:

> I have two classmates, a boy and a girl. I knew them in my middle school. At the beginning, the girl's grades were much higher than the boy's, but suddenly the boys improved so quickly that he finally surpassed the girl in exams. Based on my own observation, he only interacted with teachers in class, without doing too much exercises… I did not understand why. That was the first time I realized there were indeed some intelligence differences between boys and girls.

Student C observed that boys could improve their exam scores easier than girls. she also felt frustrated when she spent significant time on science learning or exercising, while some boys in her classroom seemed to get the same grades as her without much effort. Student E expressed similar frustration with regard to past learning experiences in science classes:

> The grades gap between boys and girls in science subjects became clearer in high school. It seems that boys take less time and spend less energy to comprehend mathematics or physical formulas. In grade 10, before the academic separation

> between social sciences and sciences, you could notice that most of top 10 students were boys in science-related tests.

Her belief in the existence of gender-based distinction in sciences was validated by the fact that she saw boys receive higher exam scores in science subjects.

CHPATER 6

Discussion, Implications and Conclusion

By examining female students' decision-making behaviors and academic orientations in Chinese secondary education, this study aimed to investigate why female high school students are less likely to choose STEM-related subjects and career direction in the context of China. Qualitative findings based on the two studied cases and interviews explained the conflict between current science education and female students' academic/career aspirations. Qualitative results were consistent with most results from literature review, but some findings provided different insights from previous research. This chapter offers findings and discussion about two key research questions:

1. How do Chinese female students make academic decisions during their high schools between the two education directions— Arts (social sciences) and Sciences?
2. What potential factors contribute to the gender disparity in sciences direction in the context of Chinese secondary education?

Limitations of the study and implications for future research are also explored in following parts. Conclusions are drawn in the final part of this study.

Findings and Discussion

Exam-oriented Science Curriculum

Lack of confidence in sciences direction. Some female students opted away from science direction and subjects in Grade 11 because they could build neither confidence nor interest in current science curriculum. Under exam-oriented education system, students' confidence in science subjects is always associated with grades in examinations. Some female students felt that they had to give up on science as early as in their middle school because they were frustrated with their exam results at the beginning stage of science learning. However, some female students who performed well in past science learning still did not feel confident enough to further their study in science fields. This finding is consistent with Nwosu, Etiubon, and Udofia (2014), who argue that, psychologically speaking, even if girls do not feel that boys did better in STEM subjects, they still perceived that science subjects are more difficult than the social sciences, and this contributes to dropping out of sciences direction in the future.

Decreased interest in sciences subjects. Students' descriptions about science learning experience implied the absence of inquiry-based learning in science classes. Some female students implied that the current textbook/exam-oriented teaching strategies negatively affected their interest in science-related subjects. In addition, there is a contrast in these participants' pervious science learning: exercise in kinesthetic learning and group work facilitated engagement, but exam-orientated assessment killed that interest. Most science teachers in high school were more likely to offer concepts and answers directly in lectures, without soliciting students' explanation or new insights. Students correspondingly asked and offered correct answers and had few opportunities to make relationships with their personal experience in daily life. In terms of the evaluation system, the criteria for students' learning results focused on examinations of terms, pure logic, and calculations.

Although this type of traditional science teaching was often criticized by Chinese experts and researchers, it is still broadly applied in high schools and accepted by most students. Affected by exam-orientated assessment, both science teachers and students think that tactile learning/inquiry-based learning, with various physical activities, is not worthy of classroom time, though they realize the importance of such science pedagogy in improving learning passion in science subjects. One of the female students even used the phrase "sacrifice two classes" when her chemistry teacher spent two lessons having students do lab activities instead of teaching theories in textbooks. These female students complained that they had a decreased interest in science learning but still had to support the current science curriculum due to the university entrance exam.

This is especially true in high school education, where the university entrance examination is the top priority, all pedagogical practice is designed around exam preparation (Zhang, 1995). That also sets additional pressure upon schools and teachers, for their fame and qualifications in educational community primarily are tied with how many students perform well on the university entrance exam (Lewin & Xu, 1989). In addition, female students' lack of interest in traditional exam-oriented science class was also confirmed by a study conducted by Ballen, Salehi, and Cotner (2017). Researchers of this study discovered that girls are more likely to be negatively influenced by the anxiety and high pressure in high-stakes exams. Compared to boys' performance in science courses, girls showed less interest and underperformed in the exam-oriented science education. They also argue that high-stakes tests cannot accurately and sufficiently assess a student's understanding and application of science knowledge. Girls had the potential to perform better on the non-exam assessments, such as science experiments, or classroom discussion.

Lack of science-related activities. Students expressed their expectations about more practical activities, like experiments, and more associations with reality both during and after science classes. However, schools provided limited support in terms of motivating female students to take an interest in and excel at science. Only one of the two studied high schools organized regular science competitions, but students were only allowed to participate if they performed well in science class. Therefore, only a small number of students could participate. The situation was even sparser at the other school, where female students could not recall any science-related activities being provided. In terms of science-related extracurricular activities in school, some participants mentioned that high school left no time to participate in such activities, under the study pressure from university entrance examination. Davey, De Lian, and Higgins (2007) also found that students in high school spent most of their time preparing for exams.

During the interviews, one participant mentioned that learning histories of science and scientists would trigger her interest in science subjects. Similarly, Zhou (2003) argues that purely knowledge-oriented teaching, with little connections to historical context, decreases students' confidence and interest in science learning. This is because it provides students with a narrowed definition or impression of science where students often regard science as "a mystical area" filled with authority and truth (p. 4). He also states that the history of science enables students to be exposed to "the success, failure, sadness, excitement, value, and bias of scientists, the success and fallibility of science, the social, political, and moral issues of science, and the philosophy of science." (p. 5). The history of science helps students build a connection between science education and their daily life.

In addition, the stories of successful female scientists in history have the capacity to narrow the gender gap in science fields by providing girls with gender-matched role models in real life. Role model theory emphasizes that a person or a group of people in influential positions can shape young adults' development and achievement by providing possible examples to imitate (King & Multon, 1996; Nauta, Epperson, & Kahn, 1998). Lockwood (2006) also notes that a gender-matched role model, especially for girls, could greatly improve their confidence and possibility of gaining success in traditionally male-majority areas.

Limited Support of Teachers

Insufficient information and advice. Compared with parents and peers, teachers were regarded as the most helpful persons with regard to understanding and answering students' academic questions. Some students mentioned that in Chinese primary and secondary school education, head teachers were in a more influential position for students, for these teachers had more time and opportunities to communicate with students. Therefore, the academic advice and career information class teachers provided have an indirect impact on students' selection between social sciences and sciences.

However, according to the descriptions of interviewed students, both head teachers and subject teachers offered little support and limited information. Teachers seems to be more professional when answering purely academic questions in textbooks; they were less knowledgeable about students' confusion regarding future academic plan or career preparation in detail.

Lack of teachers' role model in sciences subjects. Besides teachers' direct suggestions, 'good' teachers also played a salient role in the decision-making process for female students. Although these female students, in this study listed several favorite teachers in distinguished subjects, including both male and female teachers, they all agreed that these welcoming teachers were responsible, caring, approachable, and humorous in class. These characteristics of a 'good' teacher were also mentioned in the study conducted by Gilmartin, Denson, Li, Bryant, and Aschbacher (2007).

A teacher' influence depends on whether or not students like the teacher and his/her class. Students who feel connection to teachers more willing to learn that subject. Giving attentions and interactions to students and connecting with students personally promoted learning. For instance, one female student explained that the reason of her enthusiasm in Chinese and her final decision to enter social sciences direction was closely linked to her favorite teacher: her Chinese teacher. Not surprisingly, the female students who had chosen social sciences expressed a preference for their social sciences teachers. They like social sciences because they like the teachers.

In addition, the findings of interviews indicate that although the percentage of female science teachers was greater than their male colleagues in one high school, these female students did not consider these female science teachers as role models and were not motived in science subjects. A greater percent of female teachers in science faculty cannot contribute to mitigating the gender gap in science direction. This statement was in line with the prior finding that the perception of female science teachers in high school did not affect female students' understanding of science and their interest in science-related jobs (Gilmartin, et al., 2007). Gilmartin, et al. (2007) also found that students did not show an explicit favor for teachers' gender. Female science teachers are just regarded as one branch of teachers, not scientists; therefore, 'good' female teachers in science faculty cannot become female students' role models in science community. The connections between science teaching and the professional science world are weak. Based on what they have learnt in science classes, female students cannot imagine what they will need to prepare for and how they would handle the possible challenges associated with science-related jobs (Gilmartin, et al., 2007).

Less interactions with teachers during and after class time. In addition to personal traits of being 'good' teachers, frequent interactions with teachers, especially during class time, can also help female students to increase their academic performance and interest. Some students indicated that teachers' high expectations always hide behind their interactions with students, such as eye-contact or asking students to answer questions in class. However, some students, in science classes were ignored. Teachers were more likely to pay attention to active students so they could get more students' responses and feedbacks about whether or not students had understood what they taught in class. One participant observed that boys performed more positively in science classes and boys who disrupted class got additional attention. Ebbutt (1981) confirmed the finding that noisy boys received more attention in class to guarantee the normal order in class.

One student implied that close relationships with teachers, including frequent communications after class, also influenced her academic selection. However, affected by Chinese traditionally Confucian educational philosophy, teachers' authorities were emphasized in schools (Qian, 2002). As a result, only a small number of students felt comfortable consulting with teachers after class. Shy and quiet girls found it especially difficult to build close relationships with teachers in a comparatively equal position.

Implicit Stereotypes Hid in Job Opportunities

Socialized 'girls' jobs'. When choosing social sciences or sciences directions in Grade 11, female students also considered the possibility and difficulty of getting a decent job. Knight and Schultz (2006, 1993, in press) also stated that the job opportunities in local labor markets influenced students' academic directions and choices. One student mentioned that the relative information in mass media and social websites gave her original impressions of certain jobs. Gibbons (2011) confirms the close linkage between social media and employment market. He states that public media had become unconsciously and consciously complicit in creating the socialized environment where female employees managed to pursue jobs in traditionally male-dominated areas at the expense of harmonious family life (Gibbons, 2011). Monk-Turner, Kouts, Parris, and Webb (2007) also conducted a research on stereotyped gender roles in advertisements and found that men were more likely to be chosen as main character for hi-tech or science-related products, while women's images appeared in the advertisement of household appliances or services industries.

Overvalued university diploma. Chinese high school students also associated job opportunities with a university degree. All the participants believed that one of the most necessary premises to securing a decent job was a university degree, at least in recent years. Davey et al. (2007) also confirmed the finding that the Chinese education system gave priority to the importance of the university entrance exam. University education and certifications have long been thought to allow students to notably increase life opportunities in the context of China given that tertiary education is highly valued in China and competition, and especially for entry into prestigious universities, the competition is fierce (Davey et al., 2007).

Therefore, students' final choices between the two different academic directions were greatly influenced by their examination grades in different subjects. Some female students opted out of sciences direction based on their past learning experience because they believed they would acquire higher scores in social science subjects in China's university entrance examination. Moreover, in the context of Chinese education, because students who specialize in art, music, or physical education can increase their exam scores through extracurricular performances, student E opted for being an art-specialized student at the beginning of her high school years. For students whose academic performance are less competitive, being art-, music-, or PE-specialized students can help them secure enrollment in prestigious universities. However, almost all art-, music-, or PE-specialized students have to choose social sciences direction in grade 11. This is because they must take several months of intensive practice to improve their art, music, or PE skills before the university entrance exam, and because they believed exam performance could be promoted more easily in social sciences direction. These policies provided certain groups of students with additional chances to enter university with comparatively lower scores in university entrance exam (Davey et al., 2007). This demonstrates that when high school students and their parents make academic decisions or investments, the advantages and disadvantages are considered carefully.

Parents' Expectation

Educational background of parents. Compared with teachers' influence, these female students thought parents were less crucial on their academic decisions and they seldom talked with parents about what happened in school. In this study, none of these students' parents experienced higher education; therefore, parents were considered less reliable at guiding their daughters' academic choices. However, Fan (2003) suggest that there is an existing link between parents and their children's academic decisions. Parents' educational background affected girls' participation in STEM fields. Well-educated parents, especially mothers, play a positive role in improving their daughters' confidence and persistence in science direction while negatively reinforcing girls' gender-based stereotypes in STEM subjects.

Parents' expectations on university diploma. Although parents offered little support in students' decision-making process, all parents strongly expected their daughters to enter universities. As one participant explained, parents who had limited opportunity to attend university during their youth often projected their own dreams of higher education onto their children, which was reinforced by the requirements in labor market. In addition, Davey et al. (2007) also state that because of the one-child policy, most of Chinese families only have one child, who in turn represents the hope of whole family, and that means children in general are under more pressure to succeed in school. Under parents' expectation, Chinese students start various preparations for the university entrance exam, including supplementary classes after school, at an early age.

Stereotyped gender identity as girls and 'stable' jobs for girls. In terms of career path, most parents expected their daughters to get stable jobs, which referred to the jobs with stable salary, stable working place, and stable working time. Nurses, teachers, and civil servants were some common examples of stable jobs for girls. Parents traditionally believe that girls ought to leave a gentle, quiet and stable impression in public; thus, stable jobs are more suitable for girls' character and girls' future roles in family life as supporters.

The study found that participants' conceptions of ideal jobs and their gender-based identity as females were consistent with their parents' expectations. This is consistent with Martin and Ruble (2004) and Jia and Ma (2015), who argue that parents' stereotyped gender norms significantly contribute to girls' construction of gender-based cognition, especially in China where 'good wives' and 'wise mothers' were often seen as ideal models for women to aspire to.

Peers' Influence

Friends/classmates' choices. Solo status theory suggests that women are regarded on having stronger aspirations to change the gender composition in male-majority groups but are unwilling to enter male-majority groups (Sekaquaptewa & Thompson, 2003). However, the study's participants did not demonstrate the same inclination and preference in the streaming of social sciences and sciences directions. Most participants explained that grades were more of a determinant factor behind their academic orientations. Only the art-specialized student in the interview worried that she would be the solo person in sciences direction if she chose to enter sciences class as almost all of the art-specialized students chose social sciences direction.

Because of the similarity, there are more common topics among peers, specifically among classmates. As to the choices between social sciences and sciences direction, the participants did not think that their peers' decisions directly impacted their own, though most of them indicated that their hobbies were more likely to be influenced by peers' recommendations, such as extracurricular activities or readings. However, the findings of this study did not demonstrate whether or not peer-shared hobbies/entertainment can promote more diverse gender norms.

Frustration resulted from boys' exam performance. Most female students in the interviews indicated that some of their gender-based stereotypes about sciences subjects were reinforced by peers, specifically the academic performance of their male classmates in science subjects. Most female students agreed with the notion that girls and boys differ in several aspects, including intelligence, mindset, and traits. Some girls believed that females are good at social science by nature, while males do much better in STEM-related jobs.

The participants past learning experiences seemed to suggest that it was easier for boys to improve and excel in the STEM studies, even in a short period of time. Some female students felt frustrated when they did more science exercises and made an effort to get higher marks but were still surpassed by boys in exams. In most Chinese high schools, students' grades in each exam will be disclosed in public as a kind of motivation. However, the reality is that this kind of comparison of students' exam performance and improvement increases the possibility of reinforcing these gender-based stereotypes about science subjects. In addition, some participants also mentioned that boys are more energetic than girls, citing these PE classes where boys always concentrated on playing various sports and getting dirty instead of just standing quietly and chatting together, like what girls did. Segregation of gender and boy-dominated sports-related activities in PE classes could further reinforce gender stereotypes.

Ridenour and Hassell Hughes (2016) found girls were more likely to accept these stereotyped gender roles and norms, when they recognized themselves as incorrect or incompetent. They speculated that all-girls' environment would help female students build confidence and girls' voices would be stronger and more confident in the single-sex setting. However, they also mentioned that removing the opportunities to compete with boy might become the possible disadvantage of girls' school.

Implications

Implications for practice

There are complex and intersecting factors contributing to Chinese female students' underrepresentation in science direction in high schools; therefore, effective actions should be carried on at both the micro and macro level of institutions.

Current science curriculum should be carefully reconsidered and used in science teaching. In science class, more focus should be put on inquiry-based learning, which can be simply understood as a teaching method or a learning process that introduces topics through the process of exploration. This involves asking questions, designing experiments or studies, discussing results, acquiring new knowledge, and finally applying it to new situations. It has the capacity to help girls to develop their interest in science learning, by increasing practical applications to reality and gaining a deeper understanding of science instead of just memorizing formulas by rote. By implementing a well-designed science curriculum, female students are more likely to be involved in the science courses and be prepared for future scientific study or work. However, it also need to be further explored whether or not female high school students in Chinese education system would face additional challenges in inquiry-based learning.

Teacher- and school-wide support should also be provided to motivate girls in science learning. For instance, organizing more science-related activities, introducing more historical stories of female scientists, and developing more relationships between science learning and the real science world might positively influence female students' confidence and enthusiasm in STEM fields. In addition, schools and teachers ought to offer more detailed and updated career-related information about the labor market and more opportunities to allow students to be exposed to different types of jobs. This might encourage female students to look past the social conception of females getting a 'stable' job by learning about other possibilities for and conceptions of success for women.

The policy makers and whole social environment, including mass media, should pay more attention to female's inhibitions and the lack of females in science disciplines. Relative actions should be taken to ensure women's equal rights in several aspects. Further investigation must be done in order to explore and develop an understanding of the limitations of current university entrance examinations. Educational reform needs to be carefully designed and implemented.

Implications for Future Research

Although this study attempts to fully explore potential inhibitions and their influences on Chinese female students' academic path in high schools, there are no generalized assertions made for all female high school students in China because this study only focuses on a small-scale setting—the two Chinese high schools in a middle-sized city of China. Cautions should be taken when generalizing the results in other countries, states, or provinces where educational system and assessment standards differ greatly. The discussion and analysis from girls' experience do not provide a comprehensive understanding of female underrepresentation in STEM field. However, the current study is expected to identify potential psychological factors that impact educational aspects of female students' learning in STEM fields, and such findings can then be tested in future quantitative research.

In addition, only six female high school students in social sciences direction in Chinese high school were interviewed in this study. The diversity of participants was taken into consideration when the research was designed so that the selection of participants covered different categories, such as the art-specialized students and ordinary candidates of university entrance exam, and students from urban areas and students living in comparatively rural parts. However, the parenting environment of the selected participants might offer less variety as none of their parents experienced university/college education. Thus, the influence of parents' educational background on girls' academic choices needs to be further investigated. Moreover, more data from female grade 11 students in the sciences stream could possibly provide a new perspective and more comprehensive representation of female's schooling experience in science learning.

There is hope in this regard as China's exam system is changing. It is reported that the academic streaming between science and arts direction might be cancelled in several years and all Chinese school students need to register nine compulsory subjects in high schools and university entrance exam. Therefore, future work is required to explore these changes and their corresponding influences on girls' participation in STEM areas. Larger-scale studies on addressing female underrepresentation in STEM subjects are expected to encourage female students' participation and improve female students' confidence in science-related disciplines. The effectiveness of current suggestions and advices still remains uncertain.

Conclusion

The findings of this research indicated that female students' underrepresentation in science subjects and fields resulted from complex, diverse, and intersecting factors. The influence of teachers, parents, peers, labor market, and science curriculum collectively shaped female students' academic and career choices in Chinese high schools.

School and current science curriculum failed to encourage girls' persistence in science. Examination-orientated content and assessment system of science subjects made girls less interested and confident in furthering their sciences studies. Schools also failed to provide additional chances for girls to engage in science as they did not organize science-related activities to engage or motivate girls' scientific thinking and eliminate their uncertainty or fear about advanced science learning. Neither did they include pedagogies, such as teaching historical narratives regarding scientists, which typically interest girls.

Moreover, neither subject teachers nor head teachers offered adequate and detailed information about the differences between social sciences and sciences directions in terms of accessible majors in higher education and possible employment opportunities in the labor market. Neither were science teachers regarded as the positive role models for female high school students, and so they did not encourage their interest in STEM areas. There is also a lack of effective interactions and communications between teachers and students, especially for female students in science classes.

The participants' academic choices were closely associated with job opportunities in the local labor market. Findings implied that girls were more likely to pursue traditionally female-dominated jobs, like nursing and teaching. In addition, university degrees are required for several types of employment, thus the importance of universities education was emphasized in Chinese education. As a result, the participants tended to choose the academic direction in which they felt confident enough to secure the grades required to gain entrance into university.

Parents' influence, upbringing, and environment were central to developing students' personal characteristics. Parents' socialized their daughters to accept stereotypes about female identity by expecting them to behavior appropriately like socialized girls and pursue stable jobs without demanding requirements and work pressure.

In terms of peers' influence, participants suggested that the direct influence of peers' was limited for female students' final academic inclinations in the Grade 11 streaming between social sciences and sciences. However, the outstanding academic performance of some boys in science classes and exams were noticed to have a negative impact on these girls' confidence in science learning and reinforced the existence of gender-based differences in science areas.

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APPENDIX A

Interview Recruitment Letter

Date:

Dear Students,

We are conducting a study about female underrepresentation in science-related subjects. This study focuses on the potential reasons why female high school students in China are less likely to choose STEM subjects and direction, and is being conducted as part of my master's thesis through the Department of Education under the supervision of Dr. George Zhou. As you may know, there is always an imbalance of gender ratio in "Math and Sciences" direction. As Chinese high school students, your opinions will be important to this study. Thus, I would appreciate the opportunity to speak with you about your experiences.

Participation in this study is voluntary, and would involve interviews in an alternate location at a convenient time. There are no known or anticipated risks to your participation in this study. The questions are quite general. You may decline to answer any questions if you feel do not wish to answer. All information you provide will be considered confidential and grouped with responses from other participants. Further, you will not be identified by name in my thesis or any report, publication resulting from this study.

I would like to assure you that this study has been reviewed and received ethics clearance through the University of Windsor Research Ethics Board. However, the final decision about participation is yours. If you have comments or concerns, please contact me. It is my own research and it has nothing to do with the school teachers and administrators. So feel free to make your choice: participate or not.

If you are willing to participate in the study, please contact me back. Thank you for your assistance with this project.

Sincerely,

Student Investigator

Lizhi He

APPENDIX B

Interview Question Guide

Part1

1, Where are you from? Did you grow up in countryside or city?

2. Where did you have elementary and middle school? (Countryside or city)

3, What is your parents' educational background? (their highest degrees and majors in universities)

4. What are your parent careers?

5, Do you plan to go to university? What kind of major do you plan to choose?

6, What is your plan about your future career? And Why?

7, Have you ever thought of science-related career?

If yes, when and how did that thought stop?

If no, Why?

8, Do you think females are good at social science by nature, while males do much better in STEM-related jobs?

9, Are there any differences in intellectual ability between males and females?

10, Why did you choose your current direction ("social science" direction)?

10.1, Do you think your parents influenced your academic/career choices? How?

10.2, Do you think your teachers influenced your academic/career choices? How?

10.3, Do you think your peers influenced your academic/career choices? How?

11, Beside parent, teacher, and peers, were there any other factors that influenced your academic/career choices?

12, Among all these factors, which one was the most significant?

Part2

1, Do you like science? Do you think science is interesting for you?

2, Do you think the past science learning experience has any value to you?

3, How do you think of the way that science was taught?

4, How do you think teachers could make science more interesting for you?

5, Did you ever have a science teacher you like?

If yes, what make him or her different from others?

6, Did your school have any outside-classroom science readings or extracurricular activities that were interesting to you?

If yes, did you participant in it or not?

If no, what types of things do you think school should offer to motivate students to learn science?

APPENDIX C

CONSENT TO PARTICIPATE IN RESEARCH

Title of Study: Female Underrepresentation in STEM Subjects: A Study of Female High School Students in China

If you have any questions or concerns about this research, please contact

Lizhi He at he1y@uwindsor.ca

Or her supervisor George Zhou at gzhou@uwindsor.ca.

PURPOSE OF THE STUDY

This study aims to investigate why female high school students are less likely to choose STEM-related subjects and career direction in the context of China.

PROCEDURES

If you volunteer to participate in this study, you will be asked to participate in interviews. Each interview will be guided by open-ended questions, and will take approximately 60 minutes. The interviews will be audio recorded. It is my own research and it has nothing to do with the school teachers and administrators. So feel free to make your choice: participate or not.

If you volunteer to participate in this study, a letter of information, a letter to parents/guardians and a consent form will be sent to you and your parents to review. After about one week, I will contact you again to arrange an interview location and time that is suitable to you. All interviews will be audio recorded.

Prior to beginning the interview, I will review the content of the consent form with you and ask if you have any questions. If you do not have any questions, I will ask you to sign the consent form, and then all consent forms will be collected by me.

After I transcribe your interview, the transcript will be sent to you by e-mail. You will have an opportunity to revise (one week) your own transcript. Any changes made by you will be accepted by me, since I want to ensure that your perspectives are accurately represented. If you cannot return your revised transcript before the required date (one week), I will not accept your revised transcript and the original transcript will be used in this study. If the you return the revised transcript, the revised transcript will be kept and used in this study.

After I have carefully reviewed the transcript you revised, it may be necessary to ask you follow-up questions relating to specific details or to clarify statements.

If, after a review of the transcripts, follow-up questions are deemed necessary, I will review the content of the consent form again prior to recording any communication. The follow-up interviews will also be audio-taped. You will have the opportunity to review (and change if necessary) the transcripts (member checking) as a result of any follow-up interviews, if you so choose.

POTENTIAL RISKS AND DISCOMFORTS

There are no known potential risks or discomfort in the research. However, there may be potential psychological risks associated with the research. You may feel uncomfortable sharing your past experiences. It may once again remind you unpleasant experience and make you a little nervous. Feel free at any time to skip questions and end the interview, should you not feel comfortable.

POTENTIAL BENEFITS TO PARTICIPANTS AND/OR TO SOCIETY

You may feel relaxed when you share your study experience and some academic confusions with me. There may be no immediate direct benefits. However, you will have the opportunity to consider your future academic plan and career path more clearly.

The potential results of this study will enrich existing empirical researches on gender equity in science community by exploring the gender issue in Chinese high school education and hopefully will provide direction for future researches on this topic while informing policies that can address gender disparities in math and science programs.

COMPENSATION FOR PARTICIPATION

You will receive a notebook worth of $15. This will in no way compensate you for your time but is meant to be a small token of my appreciation.

CONFIDENTIALITY

Any information that is obtained in connection with this study and that can be identified with you will remain confidential and will be disclosed only with your permission. Audio recordings will be transferred to my password protected computer and transcribed in my office. With respect to data storage, privacy and confidentiality will be protected by securely storing collected information in a locked filing cabinet. Audio tapes will be transcribed, and double checked. The audio recordings will be destroyed after they have been transcribed and checked. This will be done within three weeks after the interviews. Study reports will not mention any your identifications. In order to assure confidentiality, you will be assigned a pseudonym or given the opportunity to choose your own pseudonym.

PARTICIPATION AND WITHDRAWAL

In this research, you choose to take part in the interviewing process voluntarily. You will be informed that you may not request your data be withdrawn once the data is analyzed. If you withdraw before the data is analyzed, the information and the data you provided will be immediately deleted.

FEEDBACK OF THE RESULTS OF THIS STUDY TO THE PARTICIPANTS

The findings of this study will be made available to you by posting an executive summary of the study on the University of Windsor REB website (http://www.uwindsor.ca/reb).

Date when results are available: June 30, 2018.

SUBSEQUENT USE OF DATA

These data may be used in subsequent studies, in publications, and in presentations.

RIGHTS OF RESEARCH PARTICIPANTS

If you have questions regarding your rights as a research participant, contact: Research Ethics Coordinator, University of Windsor, Windsor, Ontario, N9B 3P4; Telephone: 519-253-3000, ext. 3948; e-mail: ethics@uwindsor.ca

SIGNATURE OF RESEARCH PARTICIPANT/LEGAL REPRESENTATIVE

I understand the information provided for the study Female Underrepresentation in STEM Subjects: A Study of Female High School Students in China as described herein. My questions have been answered to my satisfaction, and I agree to participate in this study. I have been given a copy of this form.

____

Name of Participant

______________________________________ ____________________

Signature of Participant Date

SIGNATURE OF INVESTIGATOR

These are the terms under which I will conduct research.

______________________________________ ____________________

Signature of Investigator Date

APPENDIX D

Letter to parents/guardians

Date:

Dear parents/guardians,

We are conducting a study about female underrepresentation in science-related subjects. This study aims to investigate why female high school students are less likely to choose STEM-related subjects and career direction in the context of China, and is being conducted as part of my master's thesis through the Department of Education under the supervision of Dr. George Zhou. Your daughter may participate in this research and their opinions will be important to this study. Thus, I would appreciate the opportunity to speak with your daughter.

Participation in this study is voluntary, and would involve interviews in an alternate location at a convenient time. There are no known or anticipated risks to your daughter's participation in this study. The questions are quite general. She may decline to answer any questions if she feels do not wish to answer. All information she provides will be considered confidential and grouped with responses from other participants. Further, your daughter will not be identified by name in my thesis or any report, publication resulting from this study.

I would like to assure you that this study has been reviewed and received ethics clearance through the University of Windsor Research Ethics Board. However, the final decision about participation is your daughter's. If you have comments or concerns, please contact me.

Thank you for your assistance with this project.

Sincerely,

Student Investigator

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APPENDIX E

LETTER OF INFORMATION FOR CONSENT TO PARTICIPATE IN RESEARCH

Title of Study: Female Underrepresentation in STEM Subjects: A Study of Female High School Students in China

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In this research, you choose to take part in the interviewing process voluntarily. You will be informed that you may not request your data be withdrawn once the data is analyzed. If you withdraw before the data is analyzed, the information and the data you provided will be immediately deleted.

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