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

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ABSTRACT

In China, there exists many factors such as girls' socialized gender norms and the values and pedagogy incorporated in the science curriculum that may discourage female students from choosing science courses. In order to ensure that female students have the same opportunities to reach their potential in STEM areas, it is important to understand these 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. By conducting qualitative interviews with six female students, from two Chinese high schools, the study discovers several factors behind their decision-making in course selection, including the influence of current science curriculum, teachers, labor market, parents, and peers. The findings of this study enrich existing research on gender equity in Chinese high school education and provide insights about relevant policies to address gender disparities in science programs.

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

INTRODUCTION

In grade 11, Chinese students are usually required to make a choice of their high school education between two streams. One stream focuses on the arts and social sciences including disciplines such as geography, politics, and history and the other on sciences including physics, math, biology and chemistry (Li, Gao, & Wu, 2015). Students will receive different curricula according to their selection, and will likewise take a specialized version of China's national university entrance exam, Gaokao. Students' decision between social sciences and sciences is considered as one of the most significant events in their academic study because it specifies the field or area they will continue to study in high school, determines students' academic directions and opportunities in higher education, and by large broadcast the options of their future careers (Li, Gao, & Wu, 2015).

However, there is always an imbalance of gender ratio in sciences direction (Ma et al., 2016). The Statistics of National Universities showed that the top 10 most popular majors for boys were all related to science, technology, engineering, and mathematics: the STEM subjects. In these majors, boys count more than 80% of enrollment. Female students tended to cluster in social science majors, and as a result, the number of female undergraduates in social science majors (such as sociology, education, art and psychology) was double of their male counterparts (Fan, 2011). Such differences imply girls' underrepresented participation and the lack of interests in STEM subjects. Although several studies have found that women have made impressive achievements in recent decades, especially in tertiary education, their enrollment and participation in STEM subjects is 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. Avalon (2003) observed that "Women are

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Contribution of this paper to the literature

- While there is plenty research about gender differences in STEM subjects in North American post-secondary education, this study brings a case to the literature from Chinese schools which are embedded in a quite different social and cultural context.
- This study provides evidence that female students' choices in subject learning in high school are subjective to a number of factors including current science curriculum and instruction, teachers, labor market, parents, and peers.
- While the findings of this study are in alignment with literature in general, this study provides insights how Chinese traditional culture and current social context impact gender equity in high school, which is not seen in current literature.

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).

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 (Dasgupta, Scircle, & Hunsinger, 2015). 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). It is important to find out the causes of female underrepresentation in STEM fields and search for solutions to address associated issues. In the current literature, as Legewie and DiPrete (2014) pointed out, most researchers regard the stage of college 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. However, boys' and girls' exposure to stereotypes happens during their early childhood, much earlier than university years (Tai, Liu, Maltese, & Fan, 2006). Adolescence is a more salient period both for identity formation and career aspirations (Master, Cheryan, & Meltzoff, 2015). Legewie and DiPrete (2014) therefore suggested 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.

A number of studies of high school students have explored the relationship between female students and science education through using both quantitative and qualitative methods (Dasgupta et al., 2015; Friedman-Sokuler & Justman, 2016; Legewie & DiPrete, 2014); however, these studies did not investigate Chinese social or cultural contexts or its education system. Although 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), there is no reported research that explores female students' perspectives on this matter.

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 stream in Grade 11, the study focuses on the potential influencing factors behind their academic inclinations. Two central research questions guided this study:

1. How do Chinese female students make academic decisions during their high schools between the two education directions: Social Sciences and Sciences?
2. What potential factors contribute to the gender disparity in science direction in the context of Chinese secondary education?

LITERATURE REVIEW

Implicit Stereotypes for Girls and Chinese Traditional Values

The theory of social construction of gender states that gender and gender identity are constructed by social interactions (Kelly, 1981). 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). 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 (Clandfield & Martell, 2014). That contains two parts in the stereotypes for girls: one circles several specific criteria for what are the perceived appropriate behaviors for girls, and the other emphases the importance of family roles for women.

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 have the authority. It is regarded as impolite behaviors 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. A person who can follow the authority and the majority is more likely to be appreciated.

Masculinized Science Curriculum and Women's Underrepresentation

Historically, science, more precisely Western science, was conceptualized as an androcentric and Eurocentric world where politically and socioeconomically vulnerable groups were marginalized (Roos & Marl, 2009). The nature of current science curriculum has been designed and developed from the Western science, which focuses on the masculinized values and pedagogies. 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, centered on 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.

Socialized personal traits such as quietness obedience and traditional family roles for women set additional hurdles to girls' achievement in STEM fields (Frome, Alfeld, Eccles, & Barber, 2006). 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. Girls under the Chinese education system 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).

Factors Contributing to the Formation of Gender-based Stereotypes

Girls have often been constrained and unmotivated in STEM fields and find it difficult to struggle in a hostile environment (Clandfield & Martell, 2014). 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 called 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 "quiet", "hardworking", and "stable". However, these assigned impressions are far removed from the positive evaluations. Girls are seen as simply being capable of effective mimicry, while boys are viewed as innovators (Riddell, 1989).

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 career opportunities into account when making educational choices and investments (Riegle-Crumb & Moore, 2014). Generally speaking, women face more discrimination at work, have less job opportunities, and receive lower salaries (Shu, 2004). For career opportunities

and selections, gender has always been a critical factor (Livingstone, Pollock, & Raykov, 2014). There has always been a hierarchy among the different career fields and the gender-based occupational segregation exists in China's labor market (Knight, 2016). 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). 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.

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, girls select popular 'girl' toys because they know they are expected to play with dish sets and baby dolls (Raag & Rackliff, 1998). This gender segregation of toys has situated young children into socialized gender norms. Although most parents indicate that they follow the same standards of behavior for their sons and daughters, the reality is that a large number of parents persists 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).

Women's education has always been an issue in China. Influenced by Confucian 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).

Parents' educational and financial backgrounds also influence students' participation in STEM fields (Fan, 2003). Female students from working class families may face more pressure from their families with their pursuit of higher education or careers in STEM fields since they have certain realities to consider including financial support/costs, job opportunities, time, and future income. 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 may be more effective because of their greater similarity to young students" (p. 4989). Their study found that women's schooling experiences are positively influenced when they are in groups with a female majority. 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. 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). 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. 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 sciences. 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).

METHODOLOGY

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 study 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. 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.

This study was conducted in a middle-size city of Hebei province—Tangshan. Hebei province is one of the largest provinces in China, where approximately 500,000 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 Wen High School and No. 1 High school of Kai Luan were chosen for this study because some teachers in these two schools taught the first author of this paper before. Such existing relationship allowed the researcher to approach these research sites with less bureaucratic difficulty. We also learned that there was a visible gender disparity between social sciences and sciences in both schools. To avoid potential power issue, the first author directly talked with students about the research and offered recruitment letters and information letters that contain the same information that would be found on a consent form (Van den Hoonaard, 2015). On a voluntary basis, this study recruited six female high school students, who had been enrolled in the social science stream in Grade 11.

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 Wen High School, while students E and F from Kai Luan 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. Students B, E and F grew up in cities while students A, C, and D were from rural areas. None of the parents of the participants experienced post-secondary education.

All six students participated in one-on-one semi-structured interviews. While participants were given great flexibility to share their opinions during interviews, the interviews were guided by a list of open-ended questions such as "Are there any differences in intellectual ability between males and females?" and "Why did you choose your current direction (social science)?" These questions were developed by referring to the instrument of relevant studies reported in the literature with consideration of Chinese educational and social contexts. They were reviewed by the research team members and other colleagues for clarity and relevance. The data collected through interviews included background information of participants, self-expectation, career desires, opinions about gender-based norms, previous learning experience in science classes, and interaction with peers, teachers and parents. An audio recorder was used to record all interviews. The researcher also took notes to record the information the audio recorder could not capture, such as body gestures and facial expressions and the researcher's quick reflection and insights during the interview process. Interview recordings were transcribed. The transcriptions were sent to participants within a week of the interview for the purpose of member-checking.

Interview transcriptions and field notes were analyzed following a content analysis approach, which involves a coding and re-coding process. The researcher first read through all text information several times, word by word, to label all key points and topics, and as well capture any possible deeper meaning from participants' narratives. Then, the initial coding was modified, classified, and assembled to several themes.

FINDINGS AND DISCUSSION

Exam-oriented Science Curriculum

Lack of confidence and interest in science subjects. Participants opted away from science stream in Grade 11 because they could build neither confidence nor interest in science. Under an exam-oriented education system, students' confidence in science subjects is always associated with grades in examinations. Participants A, C, and E felt that they had to give up on science as early as in their middle schools because they were frustrated with their exam results. Student C shared her experience: "Once you were frustrated in the examinations of these subjects, you probably lost confidence and gradually gave up on them. There were nine required courses…you know, I needed to pay more attention to the subjects that I was able to improve."

However, students B, D and F who performed well in past science learning still did not feel confident enough to further their study in science fields. 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 calculation in math." 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 in the future.

In addition to the lack of confidence, students B, C and D indicated that they used to enjoy science learning in primary school, but science became less appealing to them in high school. Student C, for example, mentioned the change:

> In my primary school, we only had one integrated class, called science. Science teachers lead us to build models and do experiments related to natural phenomenon…quite interesting. But later in middle school and high school, there were too much complicated theories or knowledge. I felt that I understood the topic in class, but was still confused when doing homework and got low marks in tests.

Participants' descriptions about science learning experience implied the absence of inquiry-based learning in science classes. Most science teachers in high school were more likely to offer concepts and answers directly in lectures, without soliciting students' explanation or new insights. 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 scholars (Liu & Hu, 2005; Yang, 2007), 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, although they realize the importance of such science pedagogy in improving learning passion in science subjects. Student B even used the phrase "sacrifice two classes" when she mentioned that her chemistry teacher spent two lessons having students do lab activities instead of teaching theories and practicing textbook styled problem solving. Participants complained that the current format of curriculum and instruction in science decreased their interest in science, but they expressed that such reality took place in an inevitable fashion due to the university entrance exam.

Female students' lack of interest in traditional exam-oriented science class was also confirmed by a study conducted by Ballen, Salehi, and Cotner (2017). They discovered that girls were more likely to be negatively influenced by the anxiety and high pressure in high-stakes exams. Compared with boys, girls showed less interest and underperformed in the exam-oriented science education. They argued 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. Participants expressed their expectations about more inquiry activities, experiments, and more associations with reality both during and after science classes. However, schools provided limited support in motivating female students to take an interest in and excel at science. One of these two high schools where this study took place organized regularly science competitions, but students were only allowed to participate in the competitions if they performed well in science classes, often determined by their exam scores. This requirement resulted in only a small number of students who 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, student D 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, participant E mentioned that learning histories of science and stories of scientists would trigger her interest in science subjects. She said, "I expect some biographical films and stories talking about what these scientists, who often appeared in our textbooks, really experienced." Zhou (2003) suggests 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 see the humanity side of science and break any mystery around science. Particularly, 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. 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 from 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. Participants mentioned that in Chinese primary and secondary schools, head teachers were in a more influential position for students. The academic advice and career information teachers provided would have direct impact on students' choice between social sciences and sciences. Unfortunately, participants reported that both head teachers and subject teachers offered little support and limited information. Student A said, "My teacher, who was in charge of the whole class, did not talk much about the selection between two streams or the potential opportunities for future career in details. Actually, I cannot remember what she said……I felt quite confused during that time." While Chinese teachers may be well trained in academics, they seem to be less prepared to face students' confusion regarding future academic plan or career preparation.

Lack of teacher role models in sciences subjects. A teacher's influence can vary depending on how students like the teacher. Students who feel connected to a teacher are more willing to study the subject that teacher teaches. All participants expressed a preference for their social sciences teachers. For example, participant B explained that the reason for her enthusiasm in Chinese and her final decision to enter social science stream was closely linked to her favorite Chinese language teacher. Participants liked social sciences because they liked their social science teachers.

In contrast, the interview findings indicate that although the percentage of female science teachers was greater than their male colleagues in one high school, participants 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 did not contribute to mitigate the gender gap in science direction. This statement was in line with the previous 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, Denson, Li, Bryant, & Aschbacher, 2007). Gilmartin et al. 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.

Less interaction with science teachers during and after class time. Frequent interactions with teachers, especially during class time, can also help female students increase their academic performance and interest. Students C, D, and F indicated that teachers' high expectation always hid 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. For example, participant D observed, "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." Participant C also observed that boys performed more positively in science classes and those 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.

Students B and C implied that close relationships with teachers, including frequent communications after class, also influenced their academic choices. However, affected by Confucian 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 science teachers. This may explain why in one school, female science teachers did not become a role model for participants to take science direction even though they outnumbered male science teachers. Female science teachers may need to actively reach out to female students who are not so confident to communicate with them due to their not so well academic performance or shy personality.

Implicit Stereotypes in Job Opportunities

When choosing between the social sciences or sciences streams in grade 11, participants considered the possibility and difficulty of getting a decent job in the future. Participant A mentioned that the relative information in mass media and social websites gave her original impressions of certain jobs. Marcellus (2010) 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. 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 the main character for hi-tech or science-related products, while women's images appeared in the advertisement of household appliances or services industries. Such media impacts influence females' perceptions about where jobs are located for them and what is their conventional profession.

Overvalued University Diploma

Confucius stated, *Xue Er You Ze Shi* (学而优则仕), which means that people who perform well in academic study should become governmental officials. Under this philosophy, traditional China practiced civil service exams for hundreds of years as a way to select candidates for government jobs often associated with high social status and great financial benefits. Such examination practice made Chinese people considered outstanding exam scores as the best way to achieve social mobility. The situation remains similar in China today. All participants in this study believed that one of the most necessary premises to securing a decent job was a university degree. Student D expressed her observation: "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 life."

Davey et al. (2007) 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. Therefore, students' choices between two academic streams were greatly influenced by their examination grades in different subjects. Students A and C 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, because students who are specialized 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. The

specialized students in art, music or PE often take several months of intensive training outside classrooms to improve their performance skills before the university entrance exam They believed that exam scores could be promoted more easily in social science stream than science stream in a relatively short time.

Parents' Expectation

Educational background of parents. Fan (2003) suggested an existing link between parents and their children's academic decisions. Parents' educational background affected girls' participation in STEM fields. However, in this study, participants reported that parents had less crucial influence on their academic decisions compared with their teachers and seldom talked with parents about what happened in school. An explanation for such discrepancy may come from the low education background of participants' parents. In this study, none of participants' parents experienced higher education; therefore, they might be considered by participants less reliable in guiding their daughters' academic choices. In general, it is reasonable to assume that well-educated and knowledgeable 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 participant D explained, parents who had limited opportunity to attend university themselves often projected their own dreams of higher education onto their children, which was reinforced by the requirements in the labor market. In addition, Davey et al. (2007) state that because of the one-child policy, most of Chinese families only have one child, who in turn represents the hope of the whole family, and thus children in general are under more pressure to succeed in school. Under the pressure from parents' expectation, Chinese students often take supplementary classes after school to prepare for university entrance exams.

Stereotyped gender identity and 'stable' jobs for girls. In terms of career path, parents expected their daughters to get stable jobs, which refer to those jobs with stable salary, stable work place, and stable work time. Nurses, teachers, and civil servants were some commonly perceived 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 their future supportive roles in family life.

In this study, participants' conceptions of ideal jobs and their gender-based identity as females were consistent with their parents' expectations. This finding 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 to have stronger aspirations to change the gender composition in male-majority groups but are unwilling to enter male-majority groups (Sekaquaptewa & Thompson, 2003). However, in this study, most participants did not demonstrate the same inclination and preference in the streaming between social sciences and sciences. 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 the social science stream. Participants explained that grades were more of a determinant factor behind their academic orientations. They did not think that their peers' decisions directly impacted their own, although most of them indicated that their hobbies were more likely to be influenced by peers' recommendations, such as extracurricular activities or readings.

Frustration resulted from boys' exam performance. Participants C, D, and E 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. They believed that females are good at social science by nature, while males do much better in STEM-related jobs. Such believes were reported to emerge from their past school experience. Student E expressed her 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 physics 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.

In most Chinese high schools, students' grades in each exam are disclosed in public as a kind of motivation. However, the reality is that this kind of comparison of students' exam performance increases the possibility of reinforcing these gender-based stereotypes about science subjects. Ridenour and Hassell Hughes (2016) found girls

were more likely to accept these stereotyped gender roles and norms, when they recognized themselves as incompetent.

CONCLUSIONS

This study implies that participants understood the critical nature of their decision about education streams between social sciences and sciences. Unfortunately, their decision making process was not supported with adequate information and assistance from school teachers. Often, the primary consideration underling their decision was whether they would pass the university entrance exam. Participants chose social science stream because they did better in social science classes than science classes, they were more interested in social science classes, or they thought social science scores were easier to be improved in a short period of time than science subjects. In addition, the local job market and the stereotyped appropriate jobs for girls were considered by study participants.

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). 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. As a primary component of social classification, being female 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 as being maternal, self-sacrificing, and domestic in nature. In other words, the structural arrangement of a society ought to be responsible to the stereotyped gender-based differences. To nobody's surprise, this study concludes that Chinese female students' underrepresentation in science subjects resulted from complex, diverse, and intersecting factors. These factors are embedded in the Chinese social and cultural norms. As the agencies of such sociocultural norms, teachers, parents, peers, labor market and media, and as well science curriculum collectively shaped participants' academic and career choices.

School science curriculum in the two Chinese high schools failed to encourage girls' persistence in science, which reflects that examination-orientated content and assessment system in science subjects made girls less interested and confident in furthering their sciences studies. These schools failed to provide opportunities for girls to get engaged in science as they rarely organized science-related activities or events to motivate girls' scientific thinking and eliminate their uncertainty or fear about advanced science learning. Further they did not 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 science and science streams 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 was a lack of effective interactions and communications between teachers and students, especially for female students in science classes.

University degrees are over emphasized in Chinese education. As a result, participants tended to choose the academic direction in which they felt confident enough to secure higher grades required to gain entrance into university. In addition, the participants' academic choices were closely associated with job opportunities in the local labor market. Findings implied that girls were more likely to purse traditionally female-dominated jobs, like nursing and teaching.

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 behave "appropriately" 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 their academic inclinations in Grade 11 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.

IMPLICATIONS FOR PRACTICE AND FUTURE RESEARCH

There are complex and intersecting factors contributing to Chinese female students' underrepresentation in science direction in high schools. Effective actions should take place at both micro and macro levels of institutions. Current science curriculum should be carefully reconsidered in science teaching. In science classes, more focus should be put on inquiry-based learning, which emphasizes the teaching and learning of science topics through the process of exploration. This involves asking questions, designing experiments, 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. As a result of such new science curriculum, female students are more likely to be involved in the science courses and be prepared for future education and careers in science.

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 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 beyond the social conception of females getting a 'stable' job by learning about other possibilities 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. 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.

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: two Chinese high schools in a middle-sized city of China. The discussion and analysis from participants' experience do not provide a comprehensive understanding of female underrepresentation in STEM fields. Cautions should be taken when generalizing the results in other countries, states, or provinces where educational system and assessment standards differ greatly.

The diversity of participants was taken into consideration when the research was designed so that the selection of participants covered different categories in terms of art-specialized students vs ordinary students, growing up in urban areas vs. rural areas. However, the parenting environment of the participants offered less variety as none of their parents experienced post-secondary education. Thus, the influence of parents' educational background on girls' academic choices needs to be further investigated. Moreover, data from female grade 11 students in the science stream could possibly provide a new perspective and more comprehensive representation of female's schooling experience in science learning.

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