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A comparative study of female Chinese STEM PhD students in China and New Zealand: Gendered experiences at academic conferences

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Abstract

Attending and presenting at academic conferences is an essential aspect of the doctoral journey. Academic conferences offer opportunities for PhD students to present their research, network with other researchers, and learn about the newest developments in their field. This small-scale, qualitative study explored conference experiences of nine female Chinese PhD students, four studying in China and five in New Zealand. Comparing their experiences – both at conferences and in their doctoral programs generally – provides a comparative glimpse into the ongoing gender bias faced by women in academia. Findings from semi-structured interviews indicated that domestic Chinese students faced more obstacles of a 'glass ceiling', gender-biased behaviors, and more limited support from their supervisors than their counterparts studying in New Zealand. Chinese students studying in New Zealand still faced similar gendered expectations in regard to family responsibilities, however they reported stronger support systems from supervisors and universities. Future research is needed as universities in both countries work to mitigate gender inequities in STEM fields.

Keywords: Higher education; gender bias; women in STEM; doctoral student experiences, qualitative research

Since the 1980s, doctoral education in China has experienced a rapid increase in student enrollment due to the nation's need for skilled researchers to boost social and economic development (Dai et al., 2021). In 2012, China reported a higher number of PhD graduates (53,011) than the United States (50,977) for the first time, making China "the largest incubator" of PhD students (Shen et al., 2018, p. 285). In addition, an increasing number of Chinese students pursued their PhD studies outside of China in universities with high global rankings, often with funding support from the Chinese government (Shen et al., 2018). A particular emphasis by the Chinese government is on growing doctoral expertise in Science, Technology, Engineering and Mathematics (STEM) fields because research in these areas is seen as strengthening the knowledge economy and increasing the country's global presence (Wei & Johnstone, 2019).

However, women continue to be under-represented and report gender-based inequity and marginalization as PhD students and researchers in STEM fields (Dai et al., 2021; Shen et al., 2018). According to a survey of Chinese PhD graduates in 2018, the male-female ratio was 1.78:1 (Sohu News, 2018). Data from the New Zealand Tertiary Education Commission also reveal that fewer than a third of all students working towards a STEM-related tertiary qualification are women (Government Communications Security Bureau New Zealand, 2018). Thus, there is a strong underrepresentation of women in STEM fields in China and in New Zealand.

The metaphor of the 'leaky pipeline' has been used to describe the loss of female PhD students over the course of their academic careers (Dai et al., 2021; White, 2004). Specifically, females have a lower rate of degree attainment and a higher drop-out rate than their male counterparts, due in part to implicit biases in these fields (Booker, 2018), gender-based discrimination (Ampaw & Jaeger, 2011), and low psychological well-being (Schwanke, 2013). In addition to marginalization in academia, female PhD students also report barriers related to childcare responsibilities (Case & Richley, 2014; Cidlinská, 2018), and having more complex life situations than male PhD students (e.g., undertaking domestic chores, managing social ties) (Hill & McGregor, 2006).

Attending academic conferences is seen as a gateway into postdoctoral fellowships, academic positions, and industry-related professions. Academic conferences offer PhD students opportunities to both present their research and network with experts in their field. Moreover, for female PhD students, attending academic conferences can provide positive role models, support and encouragement from women in senior academic positions (Cidlinská, 2019). Despite the importance of academic conferences, much of the prior research on female PhD students' experiences at academic conference has identified conferences as gendered spaces that present numerous challenges, including funding difficulties (Mwenda, 2010), pressure from male-dominant conference environments, a lack of female role models or peers, and family responsibilities (De Welde & Laursen, 2011). Urry (2005) notes that "the slow drumbeat of being underappreciated, feeling uncomfortable, and encountering roadblocks along the path to success" (p. 6) becomes internalized, eroding self-confidence and reinforcing to women that they do not belong in science.

China and New Zealand both have extensive education resources in the Asia-Pacific region. In the 2020 QS World University Rankings, seven of New Zealand's universities were in the top 100 in at least one subject. Tertiary education programs in New Zealand include research-intensive universities that operate separately from polytechnic vocational universities and institutes (New Zealand Government, 2021). As noted, doctoral education in China has experienced rapid development since the 1980s and now has one of the largest doctoral education systems worldwide.

Although New Zealand and China both offer research-based postgraduate education, their doctoral education structures are different (Yang, 2012). China employs a PhD model that combines coursework and research while the PhD in New Zealand universities consists solely of independent research. In addition, cultural differences in the two countries should not be overlooked: the Confucian tradition in China emphasizes the role of women to be mothers and looking after a household. It thus restricts women's engagement in the academic field and is at odds with an academic science identity (Rhoads & Gu, 2012). On the other hand, New Zealand's more open and diverse society and comparatively higher protection of women's rights may have an impact on women's engagement in academia. As a part of a larger study of female

doctoral students' experience in New Zealand, and with these different cultural contexts in mind, we compare the experiences of female Chinese PhD students studying within and outside of China to determine whether their experiences differ. Such a comparison may provide insights into the persistent gender inequities in the STEM fields. As such, the current comparative study draws on interview data from female Chinese PhD students in STEM fields in a domestic Chinese university and a New Zealand university. We look at the experience of their doctoral study broadly, and then focus more closely on their academic conference experiences.

Literature Review

This section first reviews the literature on women's tertiary participation in STEM fields, followed by a review of literature specifically in relation to their conference experiences. Finally, the theoretical framework for this study which draws on theories of gender and science identity is presented.

Women in STEM Fields

Women's persistent underrepresentation in STEM disciplines at the tertiary level is well documented (Ampaw & Jaeger, 2011; Booker, 2018; Schwanke, 2013). Although the gender gap is closing in some specific fields (e.g., biological science) and in some countries (Evers & Sieverding, 2015), gender bias persists (Booker, 2018; Ampaw & Jaeger, 2011; Lubienski, 2017). Booker (2018) defines the implicit biases in these career fields as a "glass ceiling" (p. 6), as women's chances of getting hired, promoted, or tenured in academia are limited by invisible barriers related to their gender. Lubienski's (2017) survey of doctoral graduates from a top-ranking university found that males submitted and published more articles than women across many fields, especially in natural science, bioscience, and engineering subjects, due to barriers including gendered differences in faculty support and assistantships. In addition, Schwanke (2013) and Seifiert and Umbach (2008) found that lower income expectancy for female than male researchers was an important deterrent from working in STEM fields.

In addition to factors within academia, Mandleco (2010) found that non-academic related issues also contribute to gender bias and female students' doctoral journeys. The influence of female doctoral students' family responsibility is widely discussed in the literature

(see, for example, Brown & Watson, 2010; Case & Richley, 2014; Cidlinská, 2019). Brown and Watson (2010) reported that female PhD students needed to consider demands at home when planning their studies, more so than male students. Carter et al. (2013) found that a PhD degree competes with other family goals such as marriage and having children.

In the Chinese context, research has found that non-academic related issues play a significant role in women's decision to pursue a PhD in a STEM field (Dai et al., 2021; Shen et al., 2018). The Chinese Confucian tradition emphasizes women's role as xiangfujiaozi ('相夫教子') (He, 1994), meaning women are supposed to stay at home to support their husbands by doing housework and educating children. Women rarely got educated in ancient China because the Confucian tradition believed that "lack of talent in a woman is a virtue" (He, 1994, p. 88). This traditional belief persists in Chinese society. Rhoads and Gu (2012) noted that gender-based stereotypes are quite prevalent among faculty at some universities in China. Although Dai et al. (2021) claimed that China's opening and globalization has begun to reshape the Confucian tradition, they could not conclude that gender biases have eased.

Significance of Academic Conferences

Eden (2016) noted that academic conferences reflect the structural contradictions in academia because they "constitute a space for solidarity and hierarchy" (p. 409). Despite this duality, attending academic conferences, both presenting research and attending networking events, is viewed as a critical component of the doctoral journey (Chapman et al., 2009; Cidlinská, 2018). Conference attendance acts as a direct factor influencing recruitment into post-doctoral positions and academic promotion (Sabharwal et al., 2020), creates a community of practice for knowledge development (Chapman et al., 2009), and provides networking opportunities (Brown & Watson, 2010).

In addition to practical aspects of career advancement and networking, Chapman et al. (2009) found that disciplinary understanding is heightened while participating in the socio-cultural practices of academic conferences. In addition, Cidlinská's (2019) study female PhD students in Czech illustrated that high-achieving women at conferences (e.g., female keynote speakers) provided a positive role model to encourage female PhD students to become

successful in academia. For doctoral students, attending conferences can be a deciding factor for pursuing an academic career.

The role of networking opportunities at academic conferences has also received attention in the research literature (Brown & Watson, 2010; Chapman et al., 2009; Dai et al., 2021). Whether formal or informal events, networking can allow PhD students to access senior scholars whose work has shaped their own studies (Chapman et al., 2009) or provide access to researchers who share the same research interest for future collaboration (Brown & Watson, 2010). Networking at conferences provides opportunities for PhD students to become socialized into the research field beyond their own institution.

Identification of the Research Gap

In summary, being a doctoral student is the first step to starting an academic career and a space in which they develop their researcher identity. However, most of the research on gender bias in academia has focused on early career researchers with little or not attention paid to the impacts of such gender bias onPhD students. Moreover, although several prior studies have examined gender bias in STEM fields, little research has been conducted regarding female PhD students' conference experiences. Academic conferences play an essential role in academia and are closely linked to PhD students' entry into academic fields. Investigating the conference experiences of female PhD students begins to address the research gap about gender bias persisting in female STEM students' doctoral education and may point towards strategies to address bias and increase women's retention in STEM careers.

In addition, there is a lack of research on the conference experiences of female Chinese students. Female Chinese PhD students may be influenced by factors that differ from those experienced by their western counterparts. For example, the Confucian traditions that Chinese society adheres to puts a strong focus on marriage and family. Given the growing number of postgraduate students from China, it is important to further our understanding of the differential impacts of gender on these students' academic conference experiences. Thus, the current study aimed to investigate the motivation and experiences of female Chinese PhD students studying in China and New Zealand with a specific focus on

conference experiences. The research questions guiding this study were:

1. What is the motivation of female Chinese students to pursue doctoral studies in STEM fields?
2. What are the gendered experiences of female Chinese PhD students in STEM-related PhD programs in China and in New Zealand?
3. What are female Chinese PhD students' experiences attending and/or presenting at conference?
4. How does science identity development differ between female Chinese PhD students studying in China and in New Zealand?

Study Framework

In this study, we focus on female doctoral students' conference experiences using gender and science identity conceptual lenses. We identify gender as a socially constructed concept that is pervasive, largely unconsciously applied, and embedded in structures, practices, and discourses. As such, gender is embedded in academic environments such as conference spaces and the interactions within them.

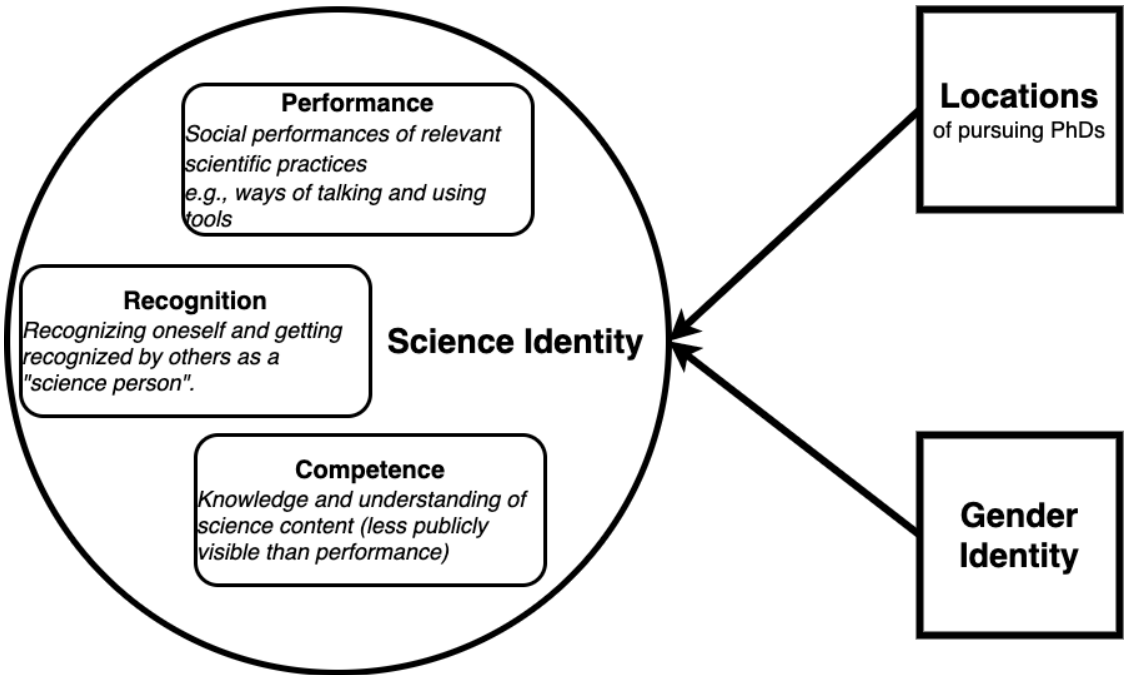
Gendered actions and interactions are based on societal views and perceptions around what constitutes femininity and masculinity (Lorber & Farrell, 1991). The conceptions of gender and the actions that confirm and sustain them influence and interact with one's identity (Barton & Osborne, 2001; Ridgeway & Kricheli-Katz, 2013). Furthermore, common gendered perceptions or stereotypes exist around science. These perceptions reiterate the notion of 'cultural fit' (the perception that 'science is for men') and 'ability' (the perception that 'men have more ability') that are pervasive in both subtle and overt ways in verbal and behavioral interactions. Within the academic environment, students learn and internalize normative behaviors, such as the accepted practices, behavior, and styles of communication, as they become part of a community of scientists through the process of socialization, for example, at conferences. Hence, we examine female doctoral students' experiences of participating in and presenting at conferences in typically male-dominated STEM fields.

Further, we draw on Carlone and Johnson's (2007) model of science identity development which stresses that identity development requires interactions with others and includes three interrelated and

overlapping dimensions: competence, performance, and recognition. Competence presents one's level of knowledge and understanding of science content and is often less overt or visible than the performance dimension. Performance entails the social performances of relevant scientific practices (e.g., ways of communication, use of tools or procedures). Recognition refers to the recognition of oneself and by meaningful others as a 'science person'.

Figure 1

Carlone and Johnson's (2007) Model of Science Identity Development



According to the reviewed literature, attending academic conferences shows a potential connection with the formation of science identity. The formation of science identity is influenced by the cultural background of female PhD students and the locations they are studying in, which may emphasize different values in relation to gender identity. A strong science identity may support female PhD students' motivation to pursue a science career, and thus increase their retention in doctoral study (Carlone & Johnson, 2007). This science identity model will be used in the discussion of findings of this study.

Methodology

Through collecting rich narratives, this study explores the detailed descriptions of female PhD students' experiences of doctoral education in STEM fields, with an emphasis on their experiences of

attending academic conferences.An interpretive approach was selected as an for uncovering participants' perceptions of their doctoral journey, conference experiences, perceived support from supervisors and the university, and apparent gender biases.

Participants

Participants were from a university in China (UC) and a university in New Zealand (UNZ). Participants were recruited through snowball sampling in the UC through the social networks of one of the members of the research team. Participants in UNZ were recruited by sending invitations to the doctoral students' directory.

We selected UC and UNZ as research sites because they share several similarities and thus enable comparison of contextual factors of interest (Creswell, 2014). UC and UNZ are both research-based, top universities in their nations. They are both large universities, each serving around 40,000 students.

Four female PhD students from UC and five from UNZ were recruited. Most of the participants were between 25-35 years old, in their second, third, or final year of their doctoral journey, and they were pursuing their doctoral studies in a range of STEM disciplines. See Table 1 for an overview of participants' demographic information. Pseudonyms are used for the participants to preserve their confidentiality.

Table 1

Study Participants' Demographics

Pseudonym	Age	Uni	Major	Year in PhD	Marital status
Linda	28	UNZ	Computer Science	2	Single
Winnie	27	UNZ	Chemical Sciences	3	Single
Alysa	26	UNZ	Bioscience	3	Single
Grace	34	UNZ	Bioscience	4	Married
Ming	25	UNZ	Environment	1	Single
Bonnie	25	UC	Chemistry	2	Single
Tina	27	UC	Chemistry	3	Single
Lily	27	UC	Bioscience	2	Single

Daisy	31	UC	Bioscience	2	Married

Interviews

The research team developed the interview protocol based on a review of prior research and validated the questions through expert advice (Dillman et al., 2009) from a STEM professor with twenty years' experience mentoring female doctoral students. Furthermore, the research team reviewed the recording of the first interview to make final modifications to the interview protocol (Willis, 2005). The interview protocol consists of four main topics: students' doctoral study, conference attendance, experiences presenting at conferences, and perceived support (see Appendix 1 for the interview protocol). The interviews were semi-structured to cover all areas of interest while allowing for follow-up questions by the researcher.

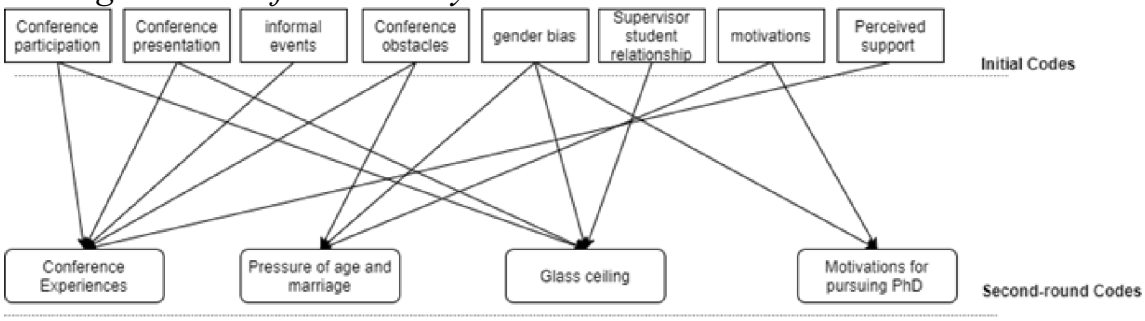
Interviews were conducted in Chinese by the first author to allow participants to express their opinions without language barriers. The interviews lasted around 40 minutes and were conducted via zoom or face-to-face. Interviews were transcribed by the first author and translated into English for analysis.

Data Analysis

A thematic analysis of the interview transcripts was conducted (Braun & Clarke, 2006). Using a mix of deductive and inductive approaches, the research team created an initial list of eight codes based on the interview topics (see Figure 2) (Miles et al., 2013). Two research team members conducted a pilot test of the broad code list in which they both coded three of the transcripts and discussed any discrepancies in coding to ensure inter-rater agreement (Armstrong et al., 1997). A second coding iteration collapsed the broad codes into four overarching themes to answer the research questions; double coding enabled excerpts from the first iteration to contribute to multiple themes. For example, a participant's description of their conference participation could be captured as a negative conference experience as well as an example of their perception of a glass ceiling. Considering that the focus of this study was conference experiences, the theme identified in this example included three sub-themes: conference participation, academic support, and supervisor- student relationships.

Figure 2

Coding Structure for the Study



Findings

The interviews yielded four main themes in regard to female Chinese PhD students' doctoral study and conference participation: their motivation to pursue a PhD, a perceived pressure of age, experiences of facing a glass ceiling, and conference experiences broadly. Within these themes, we highlight differences and similarities among participants studying in China and in New Zealand. We also consider the potential impact of participants' experiences on their science identity development.

Driven by Career Goals

For female Chinese PhD students both in China and New Zealand, their decisions to pursue a PhD were mostly driven by their aspirations for a career in academia or related industries. All the participants felt that obtaining a PhD was compulsory as an "entry ticket" for a career in academia:

> *To be honest, the motivation for my PhD study is to find a job. Graduates in the major I study (chemistry) face extreme competition in the job market. There are few suitable jobs for bachelor's and master's degree holders. (Bonnie, China).*

While the motivation to earn a PhD as a career step was common in both settings, a highly competitive job market was emphasized more by participants studying in China, where PhD degree holders compete for entry-level positions in STEM industries and universities. This phenomenon is termed "involution" in the Chinese setting (Pang & Li, 2010, p. 24), referring to the process of incessant competition from which no one benefits. Participants' reports indicated that Chinese graduates faced much more intense

competition in the job market in China than in other countries, including New Zealand.

> *Everyone in this research field has good publications, and the job vacancies in universities are always limited. The key reason [to pursue a PhD] was that I thought there were limited positions in the industry that fit our training or specialty, as a result we must compete to find a job in academia (Bonnie, China).*
>
> *If I wanted to work in higher education, I would have to have study experiences in top-ranking universities abroad. Local PhD students are always disadvantaged (Lily, China).*

Lily noted that local doctoral graduates were disadvantaged because Chinese universities prefer overseas experience and connections when employing academic staff. Alternatively, female Chinese students in New Zealand seemed to feel more confident than their local Chinese counterparts about securing a position after completing their degree. For example, Winnie said, "I think I will go back to China. I have choices, both teaching in universities and working for the government or enterprises" (Winnie, NZ).

Compared with Brown and Watson's (2010) findings that female doctoral students complete doctoral degrees to fulfill their pragmatic (career-focused), emotional and psychological needs, female Chinese PhD students in the current study were motivated foremost by their career goals as they felt they needed a PhD to be able to compete in the job market. Only one of the students noted a competence goal in regard to pursuing a PhD. Thus, we saw little mention of developing a science identity when the participants discussed their motivation to earn a PhD.

Pressure of Age and Marriage

Although the motivation to earn a PhD for career advancement is not specific to women, our study participants reported pressure to earn their degrees before a certain age.

> *Some Chinese universities … only employ PhD graduates under 35 years old (Ming, NZ).*

Additionally, nearly all of the study participants reported pressure to get married and have children. They explained further that this pressure originated from both the Chinese society generally and from within their own families specifically.

> *My parents could not understand why I put all my effort into getting a PhD, as the Chinese society has a big stereotype [against] women with PhDs. Women are expected to focus more on marriage and family (Alysa, NZ).*

Participants' comments echo Dai et al.'s (2021) argument that the traditional Confucian belief in "confining women's work to the domestic sphere" (p. 1352) tacitly restricts women from putting effort into academic careers. Although some of the female Chinese PhD students in this study noted that family responsibilities should be shared by males and females, they reported that the reality is that women are expected to balance their professional goals with family responsibility more so than male PhD students.

> *It may be more stressful for female PhDs to balance their study and family issues…especially when you are over 25 years old, pressure from parents and relatives will automatically come (Ming, NZ).*

Participants felt the pressure to get married relatively young and were worried that their choice to spend three to four years pursuing a PhD could jeopardize their chances of finding a suitable partner. Additionally, participants noted that Chinese parents generally see marriage, rather than a career, as a pathway for social mobility for their daughters, putting more emphasis on their daughter's marriage than academic success. As Lily put it:

> *As a female, I think that my parents focused more on success in marriage rather than obtaining a PhD. My family is concerned whether getting a PhD degree will prevent me from getting married and having a child. But my male colleagues in the lab do not have the same concern about marriage as I do because their parents seem less concerned about marriage (Lily, China).*

This is consistent with findings from Carter et al.'s (2013) New Zealand study that found out that female PhD students experience more societal pressure and make more concessions than male PhD students in their choices of university, effort in study, conference attendance, and employment after graduation.

In addition, although Dai et al. (2010) argued that China's modernization and globalization has brought feminist perspectives to China, resulting in less overt pressure to priorities having a family over a career, our study participants felt that this pressure is less

visible but not less real. The “pressure of age” was noted across the sample for female Chinese students pursuing their PhD in China and in New Zealand. Female Chinese students studying in New Zealand did not seem to escape the gendered expectations of Chinese society and their own families.

This pressure likely impacted on their development of a strong science identity as they felt that their families and society valued a different identity more strongly – that of a wife and mother.

Glass Ceiling

Our sample of PhD students in both China and New Zealand reported that in their experiences, especially in bioscience fields, the gender gap between PhD students seemed to be reducing. However, participants reported that even with a more equal gender distribution, they were acutely aware of a "glass ceiling" that restricts female students from success in STEM research fields (Booker, 2018, p. 6). This finding aligns with Schwanke's (2013) finding that female Canadian early career researchers' low psychological well-being comes from family pressure and societal expectations on top of the differential pressures of academia encountered by female researchers.

All four participants studying in China reported differential behaviors towards them as female PhD students. For example, they noted that supervisors had lower expectations of their work, seemed to prefer to take on male PhD students, or did not believe female researchers needed a PhD.

> *My supervisor said, "It is already good enough for females to finish their master's study, you do not necessarily need a PhD." (Tina, China).*
> *My supervisor gives me fewer chances and more "tolerance of being less productive" than male students. He did not expect me to have good academic output initially, then he gave me fewer resources [than male colleagues], then being marginalized [from the overall research process], being untrusted [to undertake individual research] afterwards, and he would challenge me more when I eventually had an output. This is like a vicious circle that I could not break (Bonnie, China).*

These narratives mirror De Welde and Laursen’s (2011) findings of female PhD students’ exclusion from the ‘old boys’ club’ of senior researchers in STEM fields. Instead of providing positive

role models and having high expectations on par with their male colleagues, supervisors' attitudes and actions weakened participants' confidence in their abilities to conduct rigorous academic research. As a result, female PhD students in our study felt it was harder to gain recognition for their abilities and negative evaluations of their competence impacted negatively on their development of a science identity. This contributed to the perception of a glass ceiling.

It is worth noting that, in this study, participants in China specifically reported that the resources distributed to female PhD students, including supervision time as well as conference and networking opportunities, are relatively limited compared to those of male students. These obstacles further served as barriers to female students' science identity development and represented a vicious cycle that inhibited female PhD students' ability to break the glass ceiling and enter careers in STEM fields.

Although study participants reported that these barriers were overt, they noted a culture of silence in which their experiences of gender bias are a 'little drama in their head' (Bonnie, China) that goes unspoken. As Bonnie stated:

> *I never tell [my supervisors] about this kind of feeling. I could feel [gender bias], but I could not tell them. I am afraid they think this is a 'storm in a teacup'; they do not even care about this! They are overwhelmingly focusing on their research (Bonnie, China).*

In contrast, Chinese female doctoral students studying in New Zealand reported better experiences compared to their counterparts in China. They described a gender-balanced, positive, and supportive community of researchers in their STEM fields. Thus, participants studying in New Zealand noted that competence and performance would be recognized and there were fewer barriers for female PhD students to succeed and develop a positive science identity. However, Winnie noted that it is not yet a post-gendered world:

> *It would be better if we do not over-focus on the word "female". If a woman has high achievement, like Chinese researcher Tu Youyou, the media or the public always report her as a "female" scientist. If an actual gender balance is achieved, we would not emphasize her female identity (Winnie, NZ).*

In comparing study participants' experiences of gender bias in their STEM programs, Chinese participants in New Zealand described

the STEM research community in New Zealand as more inclusive and supportive, which helped to build a platform for both academic and emotional support for doctoral students to achieve and gain recognition, developing a science identity (Carlone & Johnson, 2007).

Conference Experiences

In relation to conference experiences, study participants highlighted three aspects in which gender bias was apparent and that seemed to influence their science identity: conference participation, academic support, and supervisor-student relationship.

Conference Participation

A noticeable gap exists in the opportunity to attend conferences between study participants in China and in New Zealand. While female Chinese PhD students in New Zealand had attended both national and international academic conferences in their research field, local female Chinese PhD students rarely went to conferences regardless of the stage in their PhD. Beyond attending conferences, four of the five Chinese PhD students in New Zealand had presented at least two individual papers at conferences. Even Ming, who had only been enrolled in her PhD study for a few months in New Zealand at the time of the interview, had already presented a poster session at a conference. In contrast, among participants studying at domestic Chinese universities, only Bonnie and Lily had attended conferences. The conferences were not international but domestic conferences, and they had not presented their research. Thus, the students in China had fewer opportunities to gain recognition for their work outside of their own place of study.

Participants' attitudes towards conference attendance also varied by the location of their PhD study. Female Chinese PhD students in New Zealand tended to see themselves as "presenters", whereas female Chinese PhD students studying in China tended to define themselves as "listeners" (Bonnie) or "learners" (Tina), signaling different science identities. Participants in New Zealand shared their positive experience of presenting at international conferences:

> *I felt confident with my content. I thought the presentation went quite well (Winnie, NZ).*
> *I even got an offer for a post-doctoral study in Hong Kong. There is a senior researcher who is very interested*

in my work. After the presentation, he found me and asked me if I would do a post-doc (Grace, NZ).

Winnie's and Grace's narratives affirm the construction of their science identities by presenting their work (performance) and receiving positive feedback and job offers (recognition) acknowledging their skills and knowledge (competence).

In contrast, study participants in China felt that attending conferences was a passive process of receiving knowledge rather than an active process of networking and presenting. As Lily and Tina said:

My supervisor rarely took me to those kinds of formal academic events [e.g., conferences] before. In my experience, academic conferences mean more like a lecture with free food and drinks rather than a presentation (Tina, China).

In one case, Bonnie even stated that she was more likely to be a volunteer at a national conference in her field than being a registered participant.

As the conference was really advanced, we undertook some of the organizational work as volunteers. The rest of the people at that conference were mostly advanced researchers… with good articles; they interacted with each other. We were more likely to be Misses Etiquette or, simply an embarrassed "tool" of consuming free food and drinks (Bonnie, China).

Although for the female PhD students studying in China, attending conferences as part of science identity development (performance and recognition) seemed limited, the way they spoke about their experiences implied that even attending conferences as a volunteer helped them to develop the competence dimension of their science identity. These participants felt that their understanding of their research field increased by attending presentations. Nevertheless, the difference in conference experiences between Chinese domestic PhD students and those studying in New Zealand reflects a disparity of experiences and thus a disparity in their science identity development.

Academic Support

Regardless of whether our study participants were studying in China or New Zealand, they shared a concern about their English

proficiency when presenting their research. Lack of sufficient proficiency in English, especially in oral presentations, reduces their self-confidence at conferences. While this sentiment was shared across the study participants, female Chinese PhD students in New Zealand reported that they received several kinds of academic support from the university, including workshops about research methodologies, academic writing, and organizing presentations. Grace (NZ) and Winnie (NZ) also reported that their faculty held trial presentations for them to receive feedback and gain confidence before presenting at conferences. Participants studying in China seemed more concerned about their English proficiency than their counterparts studying in New Zealand. They reported that the English language support from their university and faculty was limited. Tina (China) reported that there was no support to prepare them for conference presentations and Bonnie (China) stated that the lack of confidence when using English had become a severe barrier to her research, for example when reading literature and writing drafts to be published g.

Supervisor-Student Relationship

The supervisor-student relationship was described as positive and supportive by participants studying in New Zealand, while it was reported as a challenge for participants studying in China. The adjectives that participants in New Zealand used to describe their supervisors were mainly positive. Examples of these adjectives include nice (Linda, Winnie, Ming, Alysa), friendly (Winnie, Alysa), and supportive (Linda, Winnie). This positive relationship was further reflected in the conference preparation process with supervisors giving support and guidance on presentation outlines, poster designs, and providing practice opportunities for presenting.

Bonnie, Tina, and Lily, who studied in China, referred to their supervisors as bosses and described them as being directive and holding strict control over their students' work.

> *Usually, PhD students' conference attendance is based on the supervisor's networking… I think it is a serious problem in China that supervisors dominate the study of PhD students. My supervisor determined whether I could graduate from his lab. So, I have to satisfy my supervisor to get good resources. (Daisy, China).*

The supervisor-student relationship as described by the Chinese students studying in China seemed to restrict opportunities for them to develop their own identity as scientists. They were neither able to develop their work nor see themselves as independent researchers capable of presenting their research and receiving acknowledgement and recognition for it.

In addition to Chinese supervisors being perceived as 'bosses', Lily and Bonnie felt that they could not dedicate time to attend and present at conferences without falling behind on lab work and writing journal articles. Tina noted:

> *The emphasis of the university is on publishing as much research outputs as possible. This forms an evaluation system for doctoral students as well. The graduate requirement for us includes publishing articles as the first author in high-ranking journals. I have to be really careful where I spend my time, because they may defer my graduation [if I don't reach the publication target]. (Tina, China).*

Tina's narrative illustrates a criticism that Chinese doctoral education is publication-orientated (Huang, 2021). However, as Carlone and Johnson's (2007) science identity development framework posits, the development of science identity requires not just competence but also the performance and recognition dimensions. The overwhelming focus on doctoral students' research outputs could break the balance of the science identity development by squeezing PhD students' time for conference attendance, networking, and other activities that may be beneficial.

Discussion

Drawing on Carlone and Johnson's (2007) science identity development model, this study compared female Chinese doctoral students' experiences in China and New Zealand with a particular focus on their experiences of participating in academic conferences. Overall, the conference settings enabled participants in this study to have a feeling of being accepted by the STEM community, which contributed to the recognition dimension of the science identity development model. Furthermore, conferences enabled participants to exchange knowledge of science content, developing the competence dimension of the science identity model. Moreover, study participants in New Zealand had more opportunities to present their

research at conferences, giving them more chances to develop their science identity through the performance dimension compared to their counterparts studying in China. However, study participants in China tended to seek the development of the competence dimension more through publications. Our nine participants all saw publications as necessary to survive in this competitive environment and a job market in which females are disadvantaged (Brooker, 2019).

Second, students' gender identity seemed to play a bigger role on female Chinese doctoral students' development of science identity than did the location in which they pursued their PhDs. Female Chinese doctoral students studying in China and New Zealand both strongly felt a 'pressure of age' to marry and start a family given the Confucian belief system, which they reported is strongly embedded in Chinese society. Their beliefs around female identity thus stood in strong contrast to developing a science identity through pursuing a PhD. Such societal perceptions also pervaded in the academic environment in China with study participants reporting a 'glass ceiling' effect exemplified by low expectations from supervisors and disproportionate access to funding, resources, opportunities, and support in comparison to their male colleagues under the same supervisor. Further, they reported having the added challenges of balancing family and childcare responsibilities during their studies. These findings are similar to previous research (De Welde & Laursen, 2011) and add barriers for female PhD students to develop a science identity in all three dimensions – performance, recognition, and competence.

Differences in the experiences of participants based on the location of where they pursued their PhD – in China or in New Zealand – resulted in differences in their science identity construction. Our findings also reveal a gap between conference attendance of participants studying in China and in New Zealand. Overall, the New Zealand environment was reported by participants to be more supportive for the development of female Chinese PhD students' science identity across the three dimensions of the science identity development model. Female Chinese doctoral education was reported to have a strong focus on the competence dimension, in the form of publications, and offered less support for their holistic development. Consequently, these students have fewer opportunities to attend and present at academic conferences, thus presenting a barrier to develop

the recognition and performance dimensions of their science identities.

Conclusions and Implications

Attending conferences is one key mechanism for the development of a science identity and the extent to which women feel included in the science community. It is important to understand the experience of female PhD students in attending conferences as a first step in making positive change toward a non-biased and inclusive academic environment that provides equitable opportunities for women in STEM fields.

This study found that gender identity perceptions continue to have a strong influence on the development of scientific identities among female Chinese PhD students, regardless of where they opted to complete their PhD studies. The interaction of personal (i.e., the pressure of age) and organizational factors (i.e., the perception of a glass ceiling) compounded the difficulty our study participants studying in China faced in their doctoral education, leading to more psychological and emotional pressure compared to participants studying in New Zealand. Meanwhile, the absence of psychological support from Chinese universities made our study participants feel more isolated in seeking emotional support during their study than their counterparts studying in New Zealand.

One implication of this study is that Chinese universities could adopt some of the support structures participants studying in New Zealand experienced. We suggest that a platform (e.g., discussion forum) of faculty, supervisors and doctoral students could be set up in Chinese universities to allow exchanges of ideas related to gender or broader academic and non-academic issues that emerge in female students' doctoral study processes, and more psychological care could be made available to female PhD students through a variety of channels beyond their supervisors.

Along with the rapid growth of China's economy, postgraduate education in China likely will experience a sharp expansion in the coming years. It can thus be expected that more Chinese students will pursue their doctoral studies abroad. There will be more women who enter STEM research fields. However, neither China nor New Zealand has worked out a solution to beat visible or implicit gender biases. In the novel Mrs. Dalloway, Virginia Woolf wrote, 'Mrs. Dalloway said she would buy the flowers herself'. This

notion indicates women are not limited to being 'angels at home', but can chase their personal and professional goals, breaking free from societal expectations. To support women in succeeding in academia, academic institutions and the wider society needs to combat persistent gender biases that support female PhD students' science identity development.

One of the limitations of this study is the small-scale sample which does not allow us to robustly compare differences within each country or to make generalizations. Rather, the two settings illustrate potential differences and commonalities in the experiences of these nine female Chinese PhD students. A larger-scale study could examine the phenomenon in a wider population that compares the phenomenon either within a specific country or in relation to other overseas study locations. An examination of other factors such as supervisors' own gender, which has been shown to influence student experience in previous research (White, 2004), can also be pursued as a research objective within this context.

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