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Students' Aspirations about STEM Disciplines: A Comparative Study of Gender Segregation in Higher Education among Undergraduates in China and in the UK

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Abstract: This study draws comparisons between the characteristics and extent of gender segregation among undergraduate students reading in STEM disciplines in China, and that among their counterparts in the UK. This study analyses the perceptions of these two groups of undergraduates concerning the gender gap in STEM higher education, and their STEM career aspirations. A number of factors which could significantly influence gender segregation in this context are taken into consideration. Data was collected via semi-structured interviews with the two groups of respondents from each country. A total of two hundred questionnaires were distributed at the research sites in each country. Respondents were asked to detail the reasons behind their chosen field of study, the ratio of men to women in their field of study, and their views on their STEM career ambitions. Based on the results of interviews and questionnaires in both countries, it is found that gender stereotypes appear to be relatively less prevalent in STEM disciplines with equal gender representation, and that adjusting the ratio of male to female students might lead to a significant reduction in the degree of gender segregation. In addressing gender segregation among STEM university student cohorts, this study prescribes a number of improvements in social and curricular aspects in the university education environment.

Keywords: STEM; gender; sex; China; UK; undergraduate students

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1. Introduction

In spite of the noticeable increase in female students' enrolment rate in higher education, female students are still underrepresented in certain disciplines, and there remains significant gender inequality in STEM and related disciplines (Zuazu, 2018). The acronym STEM stands for Science, Technology, Engineering and Mathematics. In terms of student enrolment, these subjects tend to be male-dominated and lacking in female representation. According to Eurogender (2017), closing the STEM gender gap "will contribute to economic growth and increase the labour market dynamic".

From my personal experience, as a Chinese student reading for a degree in Education, it is obvious to me that the majority of my fellow students are female. Among students in STEM-related fields, it is usually the reverse. I am therefore curious to find out the potential reasons behind this gender-specific contrast among students of different academic fields. Further, despite widespread academic concerns about the lack of female representation in certain disciplines, scant attention has been paid to the differences in gender segregation in higher education specifically between China and the UK. Many studies have

demonstrated that gender segregation in higher education is, to borrow the expression, "a fact of life". Gender discrimination in terms of female employment shares similarities with gender segregation among students in fields in higher education. This study explores gender inequalities in STEM subjects in higher education, and investigates the possible factors that might significantly influence gender segregation in China and the UK. This study is guided by the following research questions:

RQ1. What are the explanations for factors influencing gender segregation in STEM subjects in higher education?

RQ2. What are the possible causes of gender segregation among STEM students in China and the UK?

RQ3. How do Chinese students' perceptions on the gender gap and career aspirations in STEM fields contrast with those of their UK counterparts?

2. Literature Review

2.1. Gender and Sex

According to the WHO (2022), the term 'sex' refers to "natural and biological characteristics that a person possesses"; it is defined as "the physiological differences between men, women, and intersex persons". Such differences are evident in the genitalia, reproductive organs and genes. In sociology, the term 'gender' is culturally constructed, aiming at differentiating men and women, and reinforced through the formal and informal socialisation process. The term 'gender' also refers to rules, patterns, and behaviours that a society encourages individuals to adhere to according to their gender roles (Holmes, 2007: pp.50-52; Van den Brink et al., 2016). One explanation for gender socialisation was provided by Karl Marx (cited in Brown, 2014): individuals are socialized into a society by being indoctrinated into its norms, values, and customs. Individuals conform into traditional gender roles under the influence of family members and schools. In addition, according to Cashmiri (2020), the process of gender socialisation continues through schooling, where gender norms and values are transmitted through the hidden curriculum, attitudes and behaviour are taught through teachers and organisation in an informal way.

2.2. Gender Construction

The concept of gender is pivotal to feminist theory, and its meaning has been enriched and improved with the continuous expansion of feminist theory. From the second wave of feminist thought onwards, feminist scholars began to explore the roots of gender inequality (Author, 2015).

Later in 1970, inspired by Simone Beauvoir, Kate Millett (2000: p.37) in her book *Sexual Politics* argued that politics is a power-structured relationship, which refers to a group of people is controlled by another. Within gendered society, "Sexual dominion obtains nevertheless as perhaps the most pervasive ideology of our culture and provides its most fundamental concept of power." Moreover, she argued that all access to power is in the hands of men, and "the essence of politics is power" (ibid., p.38). She observed that men dominate and rule over women according to their innate power, which is a product of a patriarchal society. She also analysed how the patriarchy subjugates women into second-class citizens through educational, ideological economic, and violent means. She further suggested that, due to their social circumstances, males and females are really two cultures, that their life experiences are starkly different from each other. It is the differences in culture, rather than biological factors, that distinguish femininity from masculinity.

Later in 1986, the American postmodern feminist theorist Joan Scott (1986) continued to supplement social theories of gender by discussing the concept of gender from a unique point of view. Scott perceived gender as a product of social and power relations. In her study *Gender: A Useful Category of Historical Analysis*, she defined gender as having two main components. Firstly, gender "is a constitutive element of social relationships based

on perceived differences between the sexes". Moreover, "gender is a primary way of signifying relationships of power". She considered the concept of gender to comprise four interrelated elements:

Gender is related to manifold expressions of cultural symbols. For example, in the context of Western Christian tradition, the Biblical characters Eve (the first woman) and Mary (mother of Christ) are representations of women.

Gender is also linked to the norms that interpret symbolic meanings.

It is related to forms of social organisation and institutions.

It is also related to subjective identity, such as the individual's identification with gender in society.

Since the 1980s there have been further developments in the field of gender theory and practice, and the problem of gender inequality has become prominent in the minds of many academic scholars, governments and industry leaders. During the 1990s and 2000s, feminists' concerns moved away from a narrow focus on gender and related social issues. They started connecting gender with other foci of discrimination such as class, race and ethnicity, specifically analysing the relationship between gender and other forms of inequality and the connections between them. Feminist analyses of gender from a variety of perspectives and positions have led to a richer and more comprehensive understanding of gender (Author, 2015).

2.3. Gender Segregation

In academia, the root of gender segregation research was occupational gender segregation. Gender segregation, also termed sex segregation, was defined by Edward Gross in 1968 as a measure of the difference between men and women in a group (Gross, 1968; Reskin, 1993). Occupational gender segregation is the assignment and concentration of workers in different occupational categories and jobs of different natures in the labour market, on the basis of their sex. According to Reskin (1993), this type of segregation leads to a high concentration of people of one sex in one or more occupations, resulting in occupational segregation in the labour market from people of the other sex."

Gender segregation has long existed in the workplace, wherein men have been concentrated in high-risk, high-income, high-status jobs, while women are mainly concentrated in low-investment and high-stability occupations. In addition, the dominance of men in society and the subordinate position of women, coupled with the different role expectations of the two sexes in society, have led to occupational gender segregation (McGrew, 2016).

2.4. Gender Segregation in Higher Education

According to Blackburn and Jarman (1993), "Segregation by subject in secondary schools and occupational segregation form the basis of differentiation in higher education." In other words, gender segregation in higher education is seen as the diffusion of sex segregation in the labour market. It refers to the high concentration of one gender in the higher education system, resulting in segregation from the other gender.

Gender segregation in higher education, similar to occupational gender segregation, can be *horizontal* and *vertical*. According to Charles (2003), occupational gender segregation is generally divided into horizontal and vertical segregation. Horizontal segregation means that in the labour market, male and female employees are unevenly distributed, and the proportion of male and female in a certain occupation is not consistent with the proportion of men and women in the whole labour population, resulting in a high concentration of a certain gender in a certain occupation. For instance, "horizontal segregation can be found in construction, where men make up the majority of the industry's workforce, whereas childcare is almost exclusively a female occupation" (EurWork, 2017). Whereas vertical segregation means that male and female workers are distributed in the same field, with men usually enjoy higher positions and salaries, while women occupy

low-skilled positions, with lower salaries and fewer opportunities for advancement. Moreover, for the same occupation, men and women often end up in the situation of being paid differently, a phenomenon termed the 'glass ceiling' (EurWork, 2017; Charles, 2003).

Within the higher education context, there exists vertical segregation, with men and women being unequally distributed at different tiers in higher education institutions. For example, among both teachers and students, at higher levels of the hierarchy the proportion of males increases (Macarie and Moldovan, 2015). There also occurs horizontal segregation in that women and men at the same level of higher education are encouraged into different fields of study. Female students concentrate in some disciplines, while male students concentrate in others (Eurydice, 2012). Male students are dominant in their disciplines for STEM subjects, whereas female students are concentrated in their disciplines for humanities-related disciplines. However, horizontal gender segregation does not emerge at the higher education stage. Such gender gaps become evident at earlier educational stages: throughout primary and secondary education there are relatively small differences between girls' and boys' performances, especially in the fields of mathematics and science. Throughout their education, girls are unconsciously being treated differently (ibid.). The fields of mathematics and physics are regarded as being inherently masculine. Their semantic profiles, such as "hard", "serious", "distant", "sober", "strict", "robust", and "rigid", are associated with so-called "male traits". Meanwhile, there exist certain fields of study, especially those related to care, such as education and health, which are perceived as feminine and more suitable for female students (Makarova et al., 2019; Eurydice, 2012).

2.5. Gender stereotypes

Gender stereotypes also play a vital part in gender segregation in higher education. The United Nations has defined gender stereotyping as peoples' relatively fixed perceptions and ideas about male or female gender attributes (United Nations, 2022). Although the United Nations General Assembly launched the Convention on the Elimination of All Forms of Discrimination against Women, the ethos of which rejecting wrongly stereotyping is considered as an obligation, gender stereotypes still persist within society. Connell and Messerschmidt (2005) discussed the concepts of 'hegemonic masculinity' and 'hegemonic femininity', terms introduced by Connell in 1987. According to them, women and girls who fail to commodify with the traditional gender role of women are labelled as 'tomboys', whereas men and boys who cannot conform to masculine gender stereotypes may be seen as being 'sissy'. This kind of hegemonic masculinity is seen as a form of social practice that fuels and sustains the domination of women by men. In contrast with the characteristics of hegemonic masculinity, hegemonic femininity is characterized as non-aggressive, weak, and fragile, placing women in a naturally vulnerable position subordinate to men.

Gender stereotypes can also influence inequities in the education process. Traditional gender roles can be reinforced within a school's 'hidden curriculum'. According to Hernández et al. (2013), School teachers may have different expectations and attitudes towards students of different genders in the educational environment, and the prejudices resulting from implicit gender stereotypes can manifest themselves consciously or unconsciously in their teaching and in their encounters with students, which will have an impact on students' academic and career development. In addition, Mastekaasa and Smeby (2006) have claimed that male students tend to overestimate their abilities in mathematics and science, and so are more likely to choose to study in this area and pursue future careers related to science or engineering.

2.6. The Influence of Gender Segregation in Higher Education

Gender segregation in academic disciplines exacerbates gender segregation in future workplaces. Willcoxson and Wynder (2010) have noted that university disciplines can

provide the necessary basic knowledge and basic functions for several similar occupations, which constitute the most important basis for graduate career selection. Therefore, there is a high degree of correlation between disciplines and occupations, and professional gender segregation will inevitably lead to occupational segregation, which will affect the employment of graduates. Gender segregation by fields in higher education and occupational gender segregation in the labour market are interlinked manifestations of the gender stereotyping phenomenon. According to the interactional mechanism proposed by Ridgeway (1997), an important cause of the gender pay gap is the influence of information on women's career expectations, which in turn impair their determination to pursue a good salary. As a result, men and women measure the occupation and salary using different standards. The interactional mechanism theory mainly analyses problems from the supply side, that is, women's psychology and willingness. On the whole, due to the subjective underinvestment in women's human capital and the objective discrimination in the labour market, women cluster in occupations with low technical content and strong substitutability, and the overall income of such occupations is lower compared to males. Although female university students have the same human capital as male university students, on the one hand, due to the discrimination in the labour market, employers will offer different salaries to male and female university graduates with the same human capital, owing to gender differences. Most importantly, on the other hand, due to the existence of occupational gender segregation, female university students will consider the wages and occupations of their own gender group and then form an expectation that matches the whole group. However, the income of the whole group is relatively low, which naturally deviates the expectation standard of female college students and makes them accept lower remuneration from employers, which ultimately leads to lower income and social status (ibid, 1997; Vella, 1994).

3. Methodology

3.1. Research Method

Since this study is pivoted on the pragmatic research philosophy, the mixed method research design may be considered an appropriate data collection method. In addition, both quantitative and quantitative research methods are employed in this study.

Both quantitative and qualitative research methods are used in studying the behaviours of individuals. Quantitative research focuses on revealing the critical issues underlying the numerical descriptions. It therefore can help people understand social phenomena more precisely and analyse various social environments quantitatively, which is a necessary means of grasping the inherent functioning of problems or development of situations. Qualitative research refers to the process of collecting data via observations, experience, or interviews under natural environmental conditions, analysing and thoroughly studying social phenomena, and summarising concepts and providing reasonable explanations (Creswell, 2013: pp.11-13). According to Creswell and Plano Clark (2011), compared with quantitative or qualitative research methods, the mixed method research design is more flexible and comprehensive in the selection of research methods during the research process, and has better advantages in the acquisition of research results. Moreover, the mixed method research design can also provide additional perspectives and insights. Furthermore, the mixed methods research design is more likely to produce objective results.

3.2. Research Design

3.2.1. Quantitative Research Method

For this research element, I have opted to use the survey research method. Survey research is defined as "the collection of information from a sample of individuals through their responses to questions" (Check & Schutt, 2012: p. 160). Survey-based research uses

a variety of methods to attract participants, gather data, and utilize a variety of instrumental approaches (ibid.).

Among the survey research data collection tools, I have selected the questionnaire as my data collection instrument. The questionnaire is one of the most popular methods in survey-based research. Compared with other research instruments, questionnaires constitute a relatively inexpensive, quick, and effective way of obtaining a large amount of information from a large sample of people, and data can be collected in a relatively short period of time.

3.2.2. Qualitative Research Method

The questionnaire is conducive to answering the 'what' questions, while interviews entail the direct communication with participants which is required for answering the 'why' questions. As aforementioned, I decided to adopt the interview as my qualitative research tool. An in-depth interview is the most suitable method for gaining insight into participants' thoughts and perceptions. According to the UK government's website on user research (GOV. UK, 2017), it is noted that an in-depth interview provides the interviewer the opportunity to build rapport with the participants and thus make them feel comfortable. They are more likely to offer honest feedback, and the interviewer can pay attention to their expressions and body language. These cues can form a rich source of qualitative data. In order to ensure flexibility in obtaining accurate data, I choose to apply the semi-structured in-depth interview approach, enabling new ideas from the interviewees to be obtained.

3.3. Selection of Samples

Initially, I considered using a simple random sampling method to recruit STEM students at the University of Warwick, possibly via email. Under simple random sampling, everyone in the population has an equal probability of being selected (Creswell, 2013: pp.184-185). I decided to send an email with the questionnaire link to all the students participating in STEM related societies at the university. Respondents who wanted to participate further (in the interview) were asked to enter their email address at the end of the survey. To study gender inequalities in students' aspirations in STEM disciplines, I selected two countries: the UK, and China. The former is an obvious and sensible choice, given that I am currently enrolled as an overseas student at a UK institution. More importantly, the UK is considered as one of the best countries in terms of the gender equality index, scoring 72.7 out of 100 (World Economic Forum, 2020). Moreover, according to Huntington (1996, p.42), the UK is one of the main wellsprings of Western cultural values. For convenience, I chose the University of Warwick as my UK-based site for conducting my research. For the purpose of comparison, China was selected as it is one of the most populous countries in the world. It is ranked 106 in the list of countries for the gender gap index, scoring 67.6 out of 100 points. Additionally, according to Huntington (1996, p.88), China is positioned in the Sinic culture or East Asian cultural sphere. For China, Fudan University was chosen as the questionnaire distribution site.

3.4. Ethical Considerations

The confidentiality of participants has been maintained during the course of my research. All respondents are anonymous, and any personal details that might identify the respondents has been omitted. Where specifically required, the name of the interviewee is replaced with a pseudonym. I have also endeavored to omit any potentially offensive language, and I avoided stereotypical or culturally insensitive language as best as possible in the interviews and questionnaire. Furthermore, I provided each participant with my contact details so they could field their enquiries and concerns.

4. Empirical Findings

4.1. General Findings

4.1.1. Descriptive Statistics of the Sample

In this study, 200 questionnaires were distributed to students reading STEM subjects in the UK and China via the Qualtrics and Wenjuanxing (a Chinese questionnaire generating software) platforms respectively, of which 147 valid questionnaires were eventually returned, with a valid return rate of 73.5%. The basic characteristics of the returned samples are shown in the Table 1.

Table 1. Descriptive statistics of the sample.

China					UK				
Feature	**Sort**	**N**	**%**	**Cumulative %**	**Feature**	**Sort**	**N**	**%**	Cumulative %
Gender	Male	44	57.9	57.9	Gender	Male	51	71.8	71.8
	Female	32	42.1	100		Female	20	28.2	100
Degree	3 year	0	0	0	Degree	3 year	24	33.8	33.8
	4 year	76	100	100		4 year	47	66.2	100
Year of study	Freshman	7	9.2	9.2	Year of study	Freshman	13	18.3	18.3
	Sophomore	33	43.4	52.6		Sophomore	17	23.9	42.3
	Junior	22	28.9	81.6		Junior	18	25.4	67.6
	Senior	14	18.4	100		Senior	23	32.4	100

According to the above results, the sizes of the two sub-samples (from China and the UK) are roughly similar, and the gender distributions thereof are relatively average. It can be seen that the numbers of male students in the Fudan and Warwick cohorts are 44 + 51 = 95, significantly more than the numbers of female students (respectively) at 32 + 20 = 52; for both cohorts, male students outnumber the female students by a substantial margin. However, the gender ratio of the Fudan cohort is more balanced than that of the Warwick cohort, where the proportion of female students in the STEM subject cohort is only approximately 30%. In terms of length of study, the courses of all Fudan students are four years in length, while in the Warwick cohort approximately one third of students are enrolled for three-year courses of study and the other two thirds for four-year courses. In terms of grade level (Year of Study), the Warwick cohort is more evenly distributed (numbers in different levels range from 13 to 23) compared to the Fudan cohort (range: 7 to 33).

In addition, the students in both cohorts are enrolled for a wide range of undergraduate disciplines, including software engineering, electronic information and other computer software-oriented disciplines, as well as hardware research and development such as computers and hardware facilities; as regards more technical fields of science and technology, the sample also includes students reading in engineering management, aerospace engineering, computer networks, financial engineering, medicine, and even mathematics and physics. As the sample size was sufficiently large (over 40 students), instead of using Fisher's test for small samples to test for differences between sample data, the subsequent data differences were tested using Pearson's chi-squared test and the F-test in the process of testing the results.

4.2. Analysis of Factors Influencing Gender Segregation in STEM Disciplines

4.2.1. Rankings of the Importance of Factors Behind Discipline Choices

The questionnaire contained ranking questions, whereby the students were asked to prioritize the factors behind their choice of academic discipline. The smaller the value of the option, the higher the priority, that is, the smaller the numerical result obtained, the higher the priority, and the more important that choice factor is. The mean score and standard deviation obtained for each option are shown in the Table 2 below.

Table 2. Prioritisation of factors in disciplines selection.

Items	Mean	SD	Priority					
			1	2	3	4	5	6
Personal interest	2.245	1.383	67	21	30	14	15	0
Easy to study	2.850	1.377	31	36	26	32	22	0
Advice from parents/teachers	3.048	1.305	21	34	32	38	21	1
Fits my future career aspiration	2.946	1.344	24	39	29	32	22	1
Personal gender perceptions	4.034	1.161	3	16	27	31	67	3
Others	5.878	0.671	1	1	3	0	0	142

According to the statistical results, it is evident that among many of the students the main motivation behind their chosen STEM subjects was personal interest (M=2.245, SD =1.384), and that personal interest is considered by almost all students to be an important factor in their choices.

This pattern is perhaps best represented by the following statement by one respondent, who had chosen to study clinical medicine:

"Because I enjoyed studying biology and chemistry in high school, I like medicine as a choice of study in university. In addition, due to the impact of the COVID-19 epidemic, I think doctors are great and they are very selfless, which makes me more determined to study medicine. Moreover, the career of doctors is more stable."

-interview respondent, code China 1

Among the mean score results, the second-highest factor behind the students' choice of academic discipline is their perception that the subject is relatively easy to learn (M=2.850, sd=1.377); the third-highest and fourth-highest ranked factors – following the advice of parents and teachers (M=3.048, sd=1.305), and future career development (M=2.946, sd=1.344) – enjoy similar rankings (the means fluctuating around 3.000). In general, the students attach to these three factors similar degrees of importance.

Interestingly, personal gender perceptions were not generally regarded by the students as a highly important factor (M=4.034, sd=1.161). It is evident that the numbers of students who attach a high premium to personal interest, social expectations and social needs are much higher than the number of students who choose their area of study under the influence of perceived gender-specific characteristics of the subject. The students' main motivations are the needs of themselves, their families, and society, rather than preconceptions of the kind of person for whom the subject is considered suitable.

Finally, other factors (M=5.878, SD =0.671) were awarded the lowest priority. As shown in the priority count statistics, 142 (96.6%) of the 147 students thought that the other five factors were more important. This is an indication that the five factors listed in the questionnaire, based on the literature review findings are considered by many of the students to be significant criteria in the process of career selection.

There were some exceptions. For example, one interview respondent stated that she thought it more important to choose a prestigious university than a particular subject. She has indicated that she was not particularly attached to her current discipline of study:

"I didn't actually choose my course of study because of it; I just chose it because Fudan is a famous and prestigious university. I didn't have any particular attachment to the discipline."

-Interview Respondent Code, China 2

In order to further investigate the differences in the factors influencing discipline choice between students in STEM disciplines in China and those in the UK, the results for each option were further analysed statistically using Pearson's chi-squared test, the results of which are presented in the Table3:

Table 3. Statistical table of the priority of different countries on the factors of choice of subject in China and UK.

Items	Country	Priority						χ^2	df	p
		1	2	3	4	5	6			
Personal interest	China	28	12	19	7	10	0	5.871	4	0.209
	UK	39	9	11	7	5	0			
	Total	67	21	30	14	15	0			
Easy to study	China	23	13	14	17	9	0	10.884	4	0.028
	UK	8	23	12	15	13	0			
	Total	31	36	26	32	22	0			
Advice from parents/teachers	China	10	22	15	22	6	1	8.758	5	0.119
	UK	11	12	17	16	15	0			
	Total	21	34	32	38	21	1			
Fits my future career aspiration	China	14	18	15	18	10	1	2.446	5	0.785
	UK	10	21	14	14	12	0			
	Total	24	39	29	32	22	1			
Personal gender perceptions	China	1	10	12	12	41	0	9.446	5	0.093
	UK	2	6	15	19	26	3			
	Total	3	16	27	31	67	3			
Others	China	0	1	1	0	0	74	2.420	3	0.490
	UK	1	0	2	0	0	68			
	Total	1	1	3	0	0	142			

According to the statistical results presented in Table 3 above, the only significant difference between the Fudan and Warwick students in STEM disciplines is found with the criterion "Easy to study" (χ^2=10.884, df=4, p=0.028<0.05), whereby the Fudan students are more likely to choose their major if they perceive the subject as relatively easy to learn. The psychological tendency to select a major which offers the student a better chance of excelling in class and scoring high marks is more pronounced among Chinese students than British students. As for the other criteria, no significant differences were found between the Fudan and Warwick students in terms of their rankings of importance (χ^2∈[2.420,9.446], df=[3,5], ps>0.05). This indicates a certain degree of similarity among the two cohorts' perceptions of the other criteria.

In summary, both cohorts of STEM students, in China and the UK, indicated the following general ranking of priorities guiding their choice of disciplines: personal interest > perception that the subject is relatively easy to study > consideration for future career development > advice from parents or teachers > perception that chosen course of study is more suitable for male/female students > other factors. It is likely that these two groups of students enrolled at these two different universities in two very different cultural spheres prioritize personal interests over social and family expectations, as well as preconceptions as to whether the subject is suitable for male/female students. Relatively speaking, the phenomenon of gender segregation is not very evident in students' own awareness of the factors influencing their chosen areas of study, or rather, it is more difficult for students to perceive the occurrence of gender segregation. This perhaps demonstrates the indirect and subtle nature of gendered socialisation (McGrew, 2016).

4.2.2. Differences in the Proportions of Male and Female Students Studying Different Academic Subjects

Gender segregation affects a young person throughout the whole course of their childhood, from birth to adulthood, due to social expectations and gender stereotypes, along with other factors. However, this influence is usually imperceptible. To explore whether this effect predates the student's choice of major, the respondents were asked the questions, "What is your estimate of the ratio of male-to-female students on your course?",

"Are you surprised by this ratio?", "Is this what you expected when you starting your degree? Why?", and "Do you think physics, science and engineering courses are more suitable to male students than female students?" The results obtained in answer to these four questions were subjected to Pearson's chi-squared test to explore the extent to which disciplines with different male-to-female student ratios and students were affected by gender segregation.

Table 4. Difference answers in the different question by gender ratio.

Items	Sort	Male-Female ratio			Total	χ^2	df	p
		More male	Balance	More Female				
Surprise?	Yes	16(53.3%)	6(26.7%)	8(26.7%)	30(20.4%)	3.833	2	0.147
	No	67(57.3%)	35(29.9%)	15(12.8%)	117(79.6%)			
Consistent with your imagination?	Yes	67(67.7%)	20(20.2%)	12(12.1%)	99(67.3%)	15.588	2	0.000
	No	16(33.3%)	21(43.8%)	11(22.9%)	48(32.7%)			
Think science and engineering majors are more suitable for boys?	Yes	59(63.4%)	16(17.2%)	18(19.4%)	93(63.3%)	17.829	4	0.001
	No	12(36.4%)	18(54.5%)	3(9.1%)	33(22.4%)			
	Not sure	12(57.1%)	7(33.3%)	2(9.5%)	21(14.3%)			
	Total	83(56.5%)	41(27.9%)	23(15.6%)	147(100%)			

The table 4 results of the test have shown that, overall, more than half of the students identified their disciplines as being more male students than female students (56.5%), indicating that the prevalence of more males than females is most prevalent in STEM disciplines. Comparatively speaking, there are more cases in which the proportion of men and women is approximately the same (27.9 %) than where there are more female students than male students (15.6%). The results of the test have found that both the surprised and unsurprised groups faced more cases of more males than females than the other gender ratios (χ^2=3.833, df=2, p=0.147>0.05), which again verifies from the contrast between subjective and objective that gender segregation does exist in the student population of STEM disciplines.

According to the test results for the students' responses to the question, "Is this what you expected when you starting your degree?" (χ^2=15.588., df=2, p=0.000<0.001), students in their disciplines with more males than females appear to find that the course is the same as they had imagined prior to choosing their area of study (67.7%; 56.5%), while students in their disciplines with roughly the same numbers of males and females, or with more females than males, were more likely to find the course is different from what they imagined before choosing their discipline (43.8%>27.9%, 22.9%>15.6%). This indicates that, overall, the majority of students hold the view of men outnumbering women in STEM disciplines is normal, that is, students' perceptions of the gender segregation that exists in STEM disciplines have formed in their minds even before they embarked on their university studies.

According to the test results for the students' responses to the question, "Do you think physics, science and engineering courses are more suitable to male students than female students?" (χ^2=17.829., df=4, p=0.001<0.01), the students in their disciplines with more males than females tend to hold the idea that science and engineering majors are more suited to male students (63.4%>56.5%, 19.4%>15.6%), while the students in their disciplines with roughly equal numbers of men and women generally held the opposite view (54.5%>27.9%). It could be argued that the male-female ratio in the classroom might influence gender stereotyping perceptions among STEM students, and that a more balanced ratio of boys and girls in class seems to play a role in weakening the impact of gender segregation to some extent.

To further explore the perceptions of the Fudan (China) and Warwick (UK) students on this issue, a Pearson's chi-squared test was conducted, the results of which are presented in the table 5 below:

Table 5. Differences between the proportions of males and females in China and the UK on different question items.

Items	Sort	Country		Total	χ^2	df	p
		China	UK				
Male-female ratio	More male	47(56.6%)	36(43.4%)	83(56.5%)	5.332	2	0.070
	Balance	15(36.6%)	26(63.4%)	41(27.9%)			
	More Female	14(60.9%)	9(39.1%)	23(15.6%)			
Surprise?	Yes	21(70.0%)	9(30.0%)	30(20.4%)	5.055	1	0.025
	No	55(47.0%)	62(53.0%)	117(79.6%)			
Consistent with your imagination?	Yes	65(51.6%)	34(48.4%)	99(85.7%)	0.005	1	0.946
	No	11(52.4%)	37(47.6%)	48(14.3%)			
Think science and engineering majors are more suitable for boys?	Yes	55(59.1%)	38(40.9%)	93(63.3%)	7.076	2	0.029
	No	15(45.5%)	18(54.5%)	33(22.4%)			
	Not sure	6(28.6%)	15(71.4%)	21(14.3%)			
Total		76(51.7%)	71(48.3%)	147(100%)			

According to the test results, the male to female ratio of STEM students in China and the UK is roughly the same (χ^2=5.332., df=2, p=0.070>0.05), there was no significant difference. This indicates that in reality, the male-female ratio of STEM subjects in China and the UK is similar.

The results in Table 5 reveal significant differences between the two cohorts of students, which might reflect differences in gender stereotyping between the two countries. The results have found that there were significant differences between the two countries in whether they were surprised by the male-to-female ratio, whether they were in line with their expectations and whether they thought science and engineering was more suitable for males. In the question of surprise or not (χ^2=5.055., df=1, p=0.025<0.05), Chinese students were more likely to be surprised by the male-to-female ratio than British students (70.0%>51.7%), while British students were not surprised by the male-to-female ratio (53.0%>48.3%). In terms of whether they think science and engineering is more suitable for male students, Chinese students are more likely to think science and engineering is more suitable for male students (59.1%>51.7%), while British students were more likely to express uncertain and negative views (54.5%<71.4%). In contrast, both Chinese and British students were more likely to express their assumptions about the current male-to-female ratio (χ^2=0.005., df=1, p=0.946>0.05). The results have also found that Chinese students were more likely than British students to believe that science and engineering subjects were more suited for males than for females.

According to one interviewee:

"From my perspective, girls are not suitable for studying mechanics and metallurgy because they need to be exposed to the sun and the employment environment is not that friendly for females. But I don't know much about males, and I don't feel there are restrictions. For example, nursing is very popular with male students."

-interviewee code, China 1

The findings presented above lend support to the notion that career choices and areas of study in university influence each other (Willcoxson and Wynder, 2010), that vertical occupational gender segregation and 'glass ceilings' are an important factor preventing Chinese female students from choosing science and engineering. Traditional occupational gender stereotypes also deepen the misconceptions about university students' choice of study (Hartmann, 1976).

4.2.3. Differences in the Performance of Students of Different Majors by Gender

Different academic subjects bear characteristics which impose different needs on the student. With STEM subjects, the student is expected to be scientifically and technically competent. In this regard, according to Van Goozen et al. (1995), the biological relationship theory infers that males are likely to dominate classes and be more successful in STEM disciplines. However, no previous work has considered whether this 'male dominance' is consistent and prevalent across the STEM subjects. In response, it was considered necessary to conduct a chi-squared test to investigate the differences between male and female students in the performance of subjects.

Table 6. Test for differences in academic performance by gender ratio.

Items	Sort	Male-Female ratio			Total	χ^2	df	p
		More male	Balance	More Female				
Performs better	Male	27(73%)	3(8.1%)	7(18.9%)	37	12.716	4	0.013
	Female	22(62.9%)	9(25.7%)	4(11.4%)	35			
	Similarly	34(45.3%)	29(38.7%)	12(16%)	75			
Some majors are more suitable for male/female	Yes	55(59.8%)	18(19.6%)	19(20.7%)	92	10.990	4	0.027
	No	19(52.8%)	14(38.9%)	3(8.3%)	36			
	No idea	9(47.4%)	9(47.4%)	1(5.3%)	19			
	Total	83(56.5%)	41(27.9%)	23(15.6%)	147(100%)			

The results in the table 6 above indicate that, among majors with different gender ratios (χ^2=12.716., df=4, p=0.013<0.05), male students outperformed female students in their disciplines with more males than females, and more females than males (73.0%>56.5%, 18.9%>15.6%). However, where the gender ratio of males and females is more equal, male and female students appear to perform equally well (38.7%>27.9%).

To further investigate whether the students were aware of these differences, their answers to the statement "Some subjects are more suitable for men/women" were analysed. The results of the test (χ^2=10.990., df=4, p=0.027<0.05) show that students with more males than females, and more females than males, were more likely to agree with this viewpoint (59.8%>56.5%, 20.7%>15.6%), while students with equal proportions of males and females were more likely to say that they were unsure, or in disagreement with the viewpoint (47.4%>38.9%>27.9%). The results of this test indicate on the one hand that the perception of gender segregation is more pronounced in disciplines comprising different proportions of men and women, and that many of the students appear not to be fully aware of the potential impact of gender segregation. On the other hand, it could be that the experience of being in a class with equal proportions of men and women might impact positively on the student's attitude and awareness of gender segregation.

To explore the differences in academic performance between the Fudan (China) and Warwick (UK) students, the students were divided into these two groups and their results processed using a difference test. The test results are shown in the following table 7:

Table 7 The difference test in academic performance between different male and female ratios in different countries.

Items	Sort	Country		Total	χ^2	df	p
		China	UK				
Performs better	Male	26(70.3%)	11(29.7%)	37(25.2%)	8.248	2	0.016
	Female	13(37.1%)	22(62.9%)	35(23.8%)			
	Similarly	37(49.3%)	38(50.7%)	75(51.0%)			
	Yes	54(58.7%)	38(41.3%)	92(62.6%)	6.673	2	0.036

Some majors are more suitable for male/female	No	12(33.3%)	24(66.7%)	36(24.5%)
	No idea	10(52.6%)	9(47.4%)	19(12.9%)
	Total	76(51.7%)	71(48.3%)	147(100%)

The results show a significant difference between the two groups of students based at universities in the two countries in terms of perceiving which gender performs better in STEM subjects (χ^2=8.248., df=2, p=0.016<0.05). Many of the Fudan students think that male students perform better than female students (70.3%>51.7%), while the Warwick students think that male and female students perform equally well, or even think that female students perform better than male students (62.9%>50.7%>48.3%). When it comes to academic performance, the two groups of students hold different views. On the question "Some subjects are more suitable for men/women", many of the Fudan students believe that some majors do have a gender bias (58.7%>51.7%), while the majority of the Warwick students disagree with this view (66.7%>48.3%). Nevertheless, gender segregation is still present in the perceptions of study among many of the students in both countries (62.6%>51.7%>48.3%).

However, in the interviews, both the Fudan and Warwick university-based respondents felt that there was no particular gender advantage in their course, with male and female students performing similarly. For example:

"There is no particular gender advantage, it has very little to do with gender."-interviewee code, China 2

"Currently girls are better in theory and about the same in hands-on practice."

-interviewee code, China 1

"Almost the same, boys and girls are equally well."

-interviewee code, UK 1

Also, when the interviewees were asked to anthropomorphise their disciplines, the majority of them tended to be gender-free in their perceptions. "*I think of my discipline as a professor with glasses, I guess, without a specific gender, an imaginative, rigorous and self-disciplined professor*", according to interviewee code China 2, who is studying biomedical engineering. "*I think of my subject as a genderless version of Vyn Richter (a character of game Tears of Themis, a psychologist and hypnotist), with a cool personality*," according to interviewee code China 1.

Overall, the results suggest that the Fudan students are more likely to hold biased views on gender segregation than the Warwick students. When considering students' perceptions of the male-to-female student ratio prior to choosing a course, and comparing the academic performance of subjects between male and female students, it is evident that many of the Fudan students have biased views of gender segregation than the Warwick students. Meanwhile, the factors influencing disciplines selection appear to be similar among the two cohorts of students, with personal interest being the most important factor, followed by social expectations, parental expectations and career aspirations. Although both Chinese and British students believe that the gender perception of the major itself is not an important influencing factor, according to the test results, significant differences are found in the thoughts and performance of different genders before and after enrolment.

4.2.4. Perceptions of STEM Careers by Gender Ratio

To explore whether gender segregation affects the perceptions of the students regarding their future STEM careers, a difference test was conducted on their responses to the two questions: "Male/female perform equally well in STEM careers", and "Male students are more reliable in science and technology jobs". The scores for the two questions were distributed from 1 to 5, from "strongly agree" to "strongly disagree". The higher the mean score, the more the student was in disagreement. The results of the test are shown in the table 8 below:

Table 8. Differences in perceptions of STEM careers between different male and female ratios.

Items	Male-Female ratio	N	Mean	sd	F	p	LSD
Men and women can do equally well in STEM careers	More male	83	2.217	0.976	0.820	0.442	——
	Balance	39	2.256	1.272			
	More female	23	1.913	1.203			
women are not as reliable enough as men in STEM jobs	More male	83	3.217	1.148	1.114	0.331	——
	Balance	39	3.564	1.252			
	More female	23	3.304	1.295			

The results indicate that students at both universities in their disciplines with different male-to-female ratios studying different subjects hold the view that male and female students perform equally well in STEM careers (M ∈ [1.913,2.256]; all values in this interval are less than 3, F=0.820, p=0.442>0.05). Moreover, many of them were opposed to the idea that males are more reliable (M ∈ [3.217, 3.561]; all values in this interval are greater than 3, F=1.114, p=0.331>0.05). This indicates that many of these undergraduate students of both sexes hold the view that the performances of men and women in STEM related jobs are similar, and that both male and female STEM professionals are likely to be reliable.

To explore whether there exist significant differences between the Fudan (China) and Warwick (UK) students on this issue, the groups were sub-divided and analyzed using the one-way ANOVA difference test; the results are shown in the table 9:

Table 9 Differences in perceptions of jobs in science and technology by gender ratio in different countries.

Country	Iterms	Male-Female ratio	N	Mean	sd	F	p	LSD
China	Men and women can do equally well in STEM careers	More male	47	2.532	1.039	0.259	0.772	——
		Balance	15	2.667	1.397			
		More female	14	2.357	1.277			
	women are not as reliable enough as men in STEM jobs	More male	47	3.043	1.197	2.842	0.065	——
		Balance	15	3.400	1.404			
		More female	14	3.929	1.207			
UK	Men and women can do equally well in STEM careers	More male	36	1.806	0.710	2.556	0.085	——
		Balance	24	2.000	1.142			
		More female	9	1.222	0.667			
	women are not as reliable enough as men in STEM jobs	More male	36	3.444	1.054	5.327	0.007	More male、Balance>More female
		Balance	24	3.667	1.167			
		More female	9	2.333	0.707			

The results show that perceptions of male and female career performance in STEM disciplines among the Fudan students (China) is similar to that of the overall sample; further, no significant differences in the perceptions of male to female student performance in STEM careers among students of classes with different gender ratios of subjects. In summary, most of the students surveyed appear to agree that both men and women are equal to the task when pursuing STEM careers.

Irrespective of the gender ratio in their disciplines, most of the Warwick (UK) students generally agree that women are just as capable as men in pursuing STEM careers (M∈ [1.222,2.000] (all values in this interval are less than 3, F=2.556, p=0.085>0.05). But in terms of reliability, the Warwick (UK) students in their disciplines comprising more

women than men appear more likely to think male students are more reliable than female students in STEM career performance.

The results of the ANOVA test suggest that in the UK it could be easier to acquire the 'male advantage' out of a situation where there are more women than men in a STEM degree discipline, but also that students enrolled at UK universities are more likely to perceive men as more reliable in STEM related careers, compared with their counterparts in China. However, during the interviews, all respondents opined that men are likely to build good rapport in the future STEM workplace, and that it would be easier for men to secure employment in these fields:

"There will be a difference in salary between men and women, as women will get married and have children at a certain age and may be away from work for longer periods of time, and then companies will feel that women cannot keep up with the pace. Also, companies may have concerns in the recruitment process and be unfriendly to women, therefore gender discriminations occur."

-interviewee code, China 2

"In my opinion, men are better employed. But pretty much the same. There is not much difference between men and women. Because there is no difference between men and women in terms of physical strength when it comes to surgery, and in terms of internal medicine is pretty much the same as well."

-interviewee code, China 1

"I think men will be better employed in my future career. But the number of women will gradually rise as well, and there are many female programmers right now."

-interviewee code, UK 2

5. Conclusion

From the theoretical and empirical evidence presented in chapters 2 through 4, the following conclusions can be drawn:

In reference to the theories of gender stereotyping and main developments in this academic field described in the literature review, it may be said that gender segregation in higher education is not exogenous, namely that physiological differences between the sexes is not the main determining factor; rather, these combined with personal interests, family expectations, university reputations and social needs will influence prospective students' choice of degree subject. Under the influence of these factors, there will emerge certain gender differences in undergraduates' selection of academic subject, and some gender differences are unreasonable, resulting in the phenomenon of gender segregation in higher education.

The principal aim of this research project has been to explore the nature of, and student attitudes in relation to, gender inequality in STEM disciplines in higher education, and to compare and investigate the possible causes for gender segregation in the university classroom in China and that in the UK. Firstly, the factors that could influence gender segregation in STEM disciplines in higher education was explored. Furthermore, potential triggers for gender segregation in STEM disciplines in the two selected universities in China and the UK were identified in the findings. The perceptions of these China and UK-based undergraduates regarding gender gaps and career aspirations in STEM fields were also examined.

The choices of academic subject by the students who completed the questionnaire are to a large extent motivated by their own personal interests, particularly a passion for the subject in question (Malgwi et al., 2005). Aside from personal factors, the students' choices are also largely driven by career aspirations. However, embedded within the questionnaire data and interview transcripts are some vague imprints of gender norms, social control, and gender stereotypes within family and society, which likely have been impressed upon the students during their upbringing and earlier schooling. As the social construction of gender begins at an early age. The findings coincident with Oakley (1972) Millett

(1970) and Scott (1986)'s idea, that the society that constructs gender segregation by subjects in higher education. In more gender balanced environment, students tend to have less gender bias on disciplines. Moreover, the whole higher education system and mindset is based on male dominance, making females more likely to encounter difficulties in their studies.

Furthermore, gender stereotypes also play a role in gender segregation in higher education (Grusky, 2008). The influence of traditional gender norms still can be seen from the results in both Chinese and British students to some extent. Some students from both Chinese and British universities have express their supportive attitudes towards males are more suited to STEM disciplines. From the question about aspirations and current situation about students' future careers, the idea that society expects people to follow a specific gendered consensus, and individuals who violate the consensus are unconsciously stigmatized can be seen (Kwok-To, 2012; Hartmann, 1976). Almost all female interviewees recognize female workers are disadvantaged in the STEM labour market, and sometimes might have motherhood penalty when they return from maternity leave. The hypermasculinity phenomenon occurs in UK universities. The 'lad culture', is developing in UK universities. The lad culture further reinforces gender stereotypes to the detriment of female students.

Regarding the different perceptions of the gender gap in STEM education and career aspirations between male and female students pursuing further education in China and the UK, the findings of the interviews and questionnaires revealed few, if any, significant differences in the perceptions of male and female STEM students at Fudan, and those at Warwick universities. It is evident that most students in the whole sample hold the view that both sexes perform equally well as STEM students and professionals. However, the data suggest that students in their disciplines with more females than males in their course are less likely to believe that male students are more reliable in the workplace, and unwittingly be complicit with 'male dominance' in STEM fields.

This thesis has analyzed the gender segregation by fields in higher education through a new lens of feminism, using university students' choice of disciplines as an entry point. It has considered a number of factors that constitute the roots of such segregation in terms of individuals, social trends and the labour market by applying social gender and socialisation theory. In addition, this study has explored whether 'male dominance' persists in the context of pronounced imbalances in the male-female ratio of students reading different STEM disciplines, and draws conclusions based on a comparative study of two cohorts of students in two very different cultural spheres: Fudan University, China, and the University of Warwick, UK.

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