



Gender Differences in STEM Education in China

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Abstract. Gender differences are widespread in STEM education. There are some gender inequalities in the family, school and society. And women are also at a disadvantage in STEM educational expectations, educational opportunities, and future employment environment. Initially, parents' different educational expectations of their children have affected their children's choice of STEM courses. What's more, the distribution of STEM educational resources and the lack of gender awareness of STEM education cause women to lose self-confidence and interest in STEM. Additionally, gender differences as an educational result are also evident in STEM-related jobs. There is some phenomenon such as unequal distribution of educational resources and salaries. Women should be treated fairly in STEM, and the school and government need to establish relevant policies to protect the status and treatment of women in STEM education, reduce social stereotypes and gender discrimination against women as much as possible, so as to cultivate woman's awareness and confidence in STEM education and encourage women to develop in the direction of STEM.

Keywords: STEM education · Gender difference · Educational expectations · Social stereotypes · Gender discrimination

1 Introduction

In recent years, even if the issue of gender quality has been relatively solved, gender stereotypes and discrimination are still prevalent in STEM education. It's of great significance to respect, understand and eliminate discrimination in STEM education. The imbalance between males and females in STEM education is becoming bigger and bigger. China has not paid much attention to this aspect, and there are still some unfair phenomena. Women are at a disadvantage position in STEM education in China. After reading some research, there is little research on this topic and there are very few studies on this topic. The issue of gender difference in STEM in China has always existed, but most of the research is on higher education, so it is necessary to start research on this topic. Many studies have also made some foreshadowing on this topic. According to Pan Yunjun, the lack of "female education awareness" in school education has led to women being in a disadvantaged position in education [1]. There is a similar phenomenon occurring in STEM education. In Lan Xiong's research, in higher education, only 35% of the

total number of students enrolled in STEM-related majors. What's more, only 28% of all female researchers are involved in STEM researches [2]. Gender differences in STEM are obvious, but have not been noticed. Revealing the current status of gender differences in STEM education. Describing the impact of gender differences, especially women disadvantaged position in STEM education, from three aspects: educational expectations, educational opportunities, and future employment. Discovering some gender stereotypes and discrimination and putting forward some solutions to gender disparities, especially female's predicament in STEM education. From the perspectives of family, school and society. This study reviews the gender differences in educational expectations, STEM educational process and employment status between female and male students in China.

2 Gender Differences in STEM Educational Expectations

First of all, different educational expectations from various perspectives of individuals, families and society lead to gender differences in STEM education.

2.1 Self-expectation of STEM Education in Different Genders

As for individuals, according to Wang Lingge, adolescents' educational expectations can promote their learning attitudes [3]. Higher educational expectations often mean that they are less likely to exhibit poor learning attitudes. Students' self-educational expectations have a positive effect on students' academic performance. The higher the student's self-education expectations, the higher the corresponding academic achievement.

Nowadays, girls don't have high expectations for STEM education. Female students have excellent perceptual thought, more comprehensive ability in thinking about problems, and they are also good at memorizing. At the same time, their academic performance in science and engineering courses such as mathematics, physics, chemistry, and biology may not be very satisfactory, which leads to the majority of female students in high school choosing liberal arts as their major course. When they enter college, they are also afraid to try STEM courses, or science-related curricular, because they are afraid of failing again. They just want to stay in their comfort zone. Female students also lack role models and examples in STEM education, which also leads them to believe that girls cannot achieve satisfactory results in STEM education. In most science textbooks, scientists or well-known celebrities related to the field of science are basically male. Simultaneously, female students are worried that after choosing a STEM course they will not be able to make achievements in their future careers, so their educational expectations for STEM courses are not very high. They do not want to take this risk of choosing STEM majors.

On the contrary, male students are very willing to choose STEM education. In public opinion, male students have stronger logical thinking ability than female students, and their views on questions are also more rational. Therefore, in terms of choosing a major, male students will also choose courses related to science and engineering, including STEM education. Because it is not only closely related to what they have learned in high school, but also they can get higher promotion and development in it, laying a solid foundation for their future jobs.

2.2 Parents' Different Educational Expectation of Their Children

Family is the first school for children and parents are their first teachers that children cannot choose. Family education is not only the first step in children's study journey, but will also accompany children throughout their life. Parents' educational expectations play a fundamental role in the growth of children and their different educational expectations of their children have a deep impact on the choice of major. Most of the family values and educational expectations for children in China have similar meanings of an old saying. It goes that "Parents hope that their sons will become dragons and daughters will become phoenixes." which means that parents all hope that their children can have a bright future and make great achievements. For daughters, compared with sons, Muller indicates that parents were more likely to talk to girls about study plans, getting involved in school matters, restricting activities for their children [4]. They wish that their daughters have a safe and sound future. Parents may sometimes tell their daughters to balance adventure with rules. No matter what their daughters do, they think about the worst possible outcome. If the worst outcome is acceptable, their daughter can try it. If their daughters can't tackle it in an appropriate way, don't do it. Parents' educational expectations of girls tend to be conservative. They don't want their daughter to take the risk of choosing STEM courses they are not good at, which may leave them with an uncertain future. Due to the higher expectations from their parents, female students are even less likely to choose STEM majors. For sons, parents are willing to let their sons face and conquer challenges and tell them that as boys they should be independent, responsible and need to take up the obligation of supporting a family in the future. They focus on developing their sons' logical thinking skills and rational thinking systems, which not only have an impact on their sons' choice of courses in the future, but also on the handling of interpersonal relationships in the future.

2.3 Social Expectation of STEM Education in the Job Market

Liu and Yan's research shows that the subjective well-being of science and technology college students is significantly higher than that of liberal arts college students, and the subjective well-being of male students is significantly higher than that of female students [5]. It may be due to the fact of social expectation in different genders. Science and technology students are mostly male, and the demand for science and technology talents has increased rapidly in recent years, and their employment and higher education pressure is relatively low, so their subjective well-being is relatively high. In October 2018, the Organization for Economic Co-operation and Development (OECD) released the report "Bridging the Gender Digital Divide", revealing that among G20 countries' STEM-major college graduates, only a quarter of them are women, and the proportion of these women in STEM-major counterparts lower than men [6]. Today is an era of rapid technological development, and there is in dire need of high-quality talents with innovative spirit. And such kinds of jobs are usually associated with science and technology majors. The T in STME stands for technology, which is more in line with the needs of the society for talents. This also makes girls less welcomed than boys in job hunting. According to China Youth Daily, within two weeks, 1,600 valid questionnaires were received. There are very few female jobs in the scientific field, and most researchers are basically male. In

schools, female teachers usually teach Chinese, English, politics and so on, which can be called comprehensive or humanities courses. And science and engineering subjects like physics and chemistry are basically taught by male teachers. In terms of salaries, male researchers are paid much more than women, which also leads to low employment rates for women in science careers. Due to this unequal treatment and social expectations, females are more willing to study humanities and social sciences to meet the job market expectations of society.

3 Gender Difference in STEM Educational Opportunity

Moreover, not only in educational expectations, but also in STEM educational opportunities have great gender differences. This paper has mentioned that family is the first school for children and parents are their first teachers that children cannot choose. At the same time, there are also differences in the distribution of educational resources for sons and daughters.

3.1 The Distribution of STEM Educational Resources in Family

Most families in China began to cultivate their son's interest in science when he was a child. It can be seen from the usual toys that most of the boys' toys are related to cars, toy guns, and Rubik's cubes, which are related to the development of STEM intelligence. While daughter's toys are more limited to a small range, most of them are puppets or Barbie dolls. Some parents believe that raising a daughter is equivalent to nurturing the cohesion, atmosphere and emotions of a future family, while raising a son is to determine the height and quality of a future family. Therefore, there is a difference in the education of sons and daughters since childhood. In order for sons to have good jobs in the future, most of these jobs are usually related to science, technology, and engineering. Therefore, parents sign up for remedial classes when their sons are in primary school, such as mathematics, physics, chemistry, etc., enriching their scientific knowledge, so that they may make achievements in the future science field. While for daughters, parents usually sign up for extra-curriculum classes such as dance classes and music classes, which makes them less knowledgeable than boys in terms of scientific knowledge. Even in some rural families in China, influenced by traditional Chinese convention, there is a "boy's intellectual superiority theory" [7], and girls may have no chance to receive education, let alone STEM education.

3.2 The Lack of Gender Awareness in School

Schools, as the most significant activity place in the students' learning process, have the greatest impact on the students. But nowadays many schools lack female education awareness.

According to Pan Yunjun, "Female educational awareness" refers to a gender education concept relative to male educational awareness [1]. In the education process, on the basis of recognizing natural gender differences, in the mainstream education centered

on male value orientation, it is required from educational decision-making to implementation that every step must consider whether it has an impact on female students, avoid and correct educational decision-making behaviors that are not conducive to female development at any time, adhere to people-oriented, protect female students' rights and interests, and develop female intelligent. It is obvious that most STEM major courses' teachers are male. As time ticks away, these types of courses are gradually becoming masculine and dominated by men. Therefore, schools choose more male teachers when recruiting science teachers. In the teaching process, teachers are also more inclined to cultivate the scientific thinking of male students. Female students do not have equal treatment. Teachers tend to ask male students to answer questions and inspire them to think about new solutions. The above are manifestations of the lack of female education awareness in school education.

In terms of achievements, schools do not provide much help for female students, which to a certain extent, frustrates female students' self-confidence in learning STEM courses. And in the publicity of STEM achievements, there are very few female achievements, which also means that female students lack model roles. In Lan Xiong's research, in higher education, only 35% of the total number of students enrolled in STEM-related majors. What's more, only 28% of all female researchers are involved in STEM research [2]. Even if the government and school have made great effort to achieve equal educational rights between male and female students, under this homogenized and superficially equal educational system, it is also unfair for female students. This educational model is designed according to the physical, psychological and thinking characteristics of male students, which only takes the interests and educational requirements of male students into consideration. What's more, few people seriously study how to combine the characteristics of women and create a suitable education environment for female students. In order for women to obtain a good education and achieve great academic performance in STEM education designed with male characteristics, they need to put an effort into studying harder and harder. This problem exists not only in course education, but also in academic research in schools. There are seldom female researchers in the STEM field, and most of the research experiments are dominated by male researchers. This phenomenon also affects female access to STEM education.

3.3 Social Stereotypes on Gender in STEM Educational Opportunities

In our society, although today's educational environment is more equitable than before, there are still stereotypes about female students' learning capacity for STEM courses. According to Hill, negative stereotypes about female students' abilities in mathematics and science persist despite female considerable gains in participation and performance in science areas during the last few decades [8]. Two stereotypes are prevalent: girls are not as good as boys in math, and scientific work is better suited to boys and men. Most people think that boys are more suitable for science courses and research than girls. Almost every girl has confronted with this bias in the process of growing up: "Girls' logical thinking ability is weaker", "Girls' spatial imagination ability is worse", "Engineering requires high physical strength". Female students are at a disadvantage position in STEM education, and when they enter the job market, they are treated in a different way. Even in their professional field, the views or ideas they put forward may

be ignored or refuted. Because people think men are more rigorous and professional than women in such science areas. It's not fair to female. Under this circumstance, the mindset of some female students has been greatly affected, which makes them unable to concentrate on their own studies, which make them feel intimidated with stem subjects, thus forming a vicious circle, which makes more people think girls are not suitable for studying science. However, this point of view has no theoretical basis. Nowadays, there are some female scientists who have contributed to the development of the country, such as Tu Youyou, Lin Qiaozhi, Xie Xide, etc. There is no doubt that people have to eliminate social stereotypes on female students in STEM education and create a suitable environment for females.

4 Gender Differences as an Educational Result in Stem Related Jobs

4.1 Parents' Different Expectations on the Choice of Jobs in Different Genders

Most significantly, as an educational result, gender differences are evident in STEM jobs. Male students usually choose to continue their further study of STEM-related projects, while most girls are not very willing to choose STEM-related jobs.

In China, most parents wish their children to have a decent jobs and bright future. When it comes to decent job, it is usually associated with major companies, high salary, comfortable working environment and so on. Among many occupations, most of the STEM related jobs are high paying jobs, such as architects, actuaries, dentists, engineers, etc. That's why parents are more willing to motivate their children to choose such jobs, they don't take children's interests into account.

For men, they are more expected by their parents to work in STEM related jobs. Most architects, dentists, etc. are male-dominated, and there are very few women, which also shows that female employees are in a disadvantaged position in this field in this regard. For women, parents rarely send their daughters to work in STEM research. Scientific research means that it takes a lot of time and energy, and there is no guarantee that they will attain the achievement in the future, which is very unstable. If they find an occupation related to STEM, there is no guarantee that they will have a stable position in the future, because there are too many competitors, and girls do not have an advantage position in this area, and may be fired after working for a period of time; if they do not choose to look for a STEM related job then their parents will be very disappointed with them. A study carried by Fang Luyao, examining whether gender stereotypes exist in parental expectations, found that parents, especially mothers, showed higher science expectations for boys, which may explain why mothers tend to invest more in boys with poor science scores while parents only get involved if their daughter scientific performance exceeds educational expectations [9].

Actually, most girls will choose the former, but they fail again and again due to the mismatch of their professional background. After these failed experiences, their self-confidence is hit, and they are reluctant to take the risk of choosing STEM-related jobs and choosing so-called female-friendly jobs, such as nutritionists, nurses, yoga instructors. As a result, the number of female employees is becoming fewer and fewer

and if there are, most of them are just assistants who cannot decide some important affairs or projects. To some extent, it also reinforces male dominance in STEM-related jobs and people will tend to realize.

4.2 Career Intentions for STEM Students of Different Genders

After earning a STEM-related degree, career intentions are varied in different genders. Male's career intentions after graduation are more willing to choose STEM-related jobs and make full use of their own expertise and characteristics, and in the job market, male employees have more opportunities, while female entry threshold is higher than men and even in some non-STEM female employees' salaries are generally lower than that of male. According to Zhang Kangsi, under the same conditions, the employment opportunities for female are only 87% of those for male; whether it is occupations such as mechanical equipment repairing, cook which are relatively concentrated in men, or wholesale and retail, catering and social services, which are relatively concentrated in women, female's income is significantly lower than that of men [10].

Nowadays, the gender inequality between men and women has been noticed in university STEM education, and some changes have been taken, but the future employment issue of gender equality has not been solved, so new breakthroughs must be sought in employment. Universities are access to the society for students. After students' graduation, the school will also help students find jobs, but few female students are able to enter STEM-related jobs or businesses. Schools should play a vital role in guiding career intentions of STEM students in different and make great effort to seek gender equality. They can set up a special project for female scientific and technological talents to avoid the marginalization of most women, increase the number of female talents at the management and decision-making levels, and develop a team of scientific and technological talents with a balanced rate of male and female. As for society, setting up special funds, and increasing encouragement mechanisms are valid solutions to enhance the career intentions of female STEM students.

4.3 Gender Discrimination and Stereotype in STEM Job Market

Gender discrimination and social stereotypes are stubborn issues which have existed for a long time. They are also prevalent in the STEM job market. In the traditional convention and family environment of Chinese sons and daughters for thousands of years, females' responsibilities as daughters, wives, and mothers are still significant, and they spend more time on family roles than males. Females make great effort to seek balance in taking care of family and career planning. For scientific research, a large amount of time investment is a prerequisite for the output of results, which also leads to the rising rate of female researchers, which will gradually slow down with the increase of age and family roles. Take the Noble Prize which is one of the highest achievements in STEM as an example, according to Ren ailing, in terms of the number of scientists and the achievements of scientists, women are obviously inferior to men [11]. As of the end of the 1980s, among the 400 Nobel Prize winners in science, there were only 9 women, of which only 3 were awarded independently, and the others were acquired jointly with their husbands.

Social stereotypes are deeply rooted in people's minds. Females are considered to be incapable of distinguishing between the subject and the object, and because women resort to intuition, emotion, and cannot carry out rational thinking and reasoning, women are considered to be unsuitable for work in scientific research. Culturally, this stereotype of gender directly induces people's recognition of a biological determinism, that the difference between men and women in scientific activities is based on their biological differences. Women are less intelligent than men, especially It is the ability in mathematics and physics that is even worse than that of men. People believe that it is this "natural" difference that prevents women from engaging in scientific research or obtaining the same scientific achievements as men. From basic education to higher STEM education, most teachers are male, because people always think that men can complete assignments better than women, and their leadership skills are stronger. Even if there are a few female teachers who teach STEM courses in elite higher education, few students choose them as mentors. They are powerless because their social recognition is lower than that of men, and "strong women" is not accepted by society. Society prefers to accept so-called "kind wife and good mothers", which has undoubtedly become a stumbling block for women on the way to job hunting.

5 Conclusion

The dilemma of women in the STEM field is one of the most important problems that needs to be urgently solved at present. Firstly, families and schools have low expectations for women to learn STEM education. They should support female students to learn STEM courses and encourage them to be confident. Secondly, unequal distribution of educational opportunities and resources seriously affect female's learning process of STEM. Last but not least, contemporary social stereotypes and gender discrimination still exist which have had a very serious impact on the development of women in the STEM field, which put females in a disadvantaged position in STEM. Schools and governments need to set up policies to support women. In the future, further research may focus on the current status of women as researchers in STEM fields. An all-round view of the current state of women in such so-called male-dominated fields from multiple perspectives. This study is limited to STEM education and can only reflect part of the inequality. Women are still unequal in some other areas, such as in higher education, employment process and so on. These still need more in-depth research.

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