An Intersectional View of Gender and Socioeconomic Status Inequalities of Science Education in China

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Abstract

This critical analysis paper explores the persistent issues of equity and social justice within science education in China, focusing on the intersection of gender and socio-economic status (SES) inequalities. Despite progress in addressing educational disparities, significant challenges remain. The analysis draws on theories of social reproduction and intersectionality to highlight how cultural capital, transmitted through family backgrounds, creates unequal starting points for students. By examining the compounded effects of gender and SES, the essay addresses two key questions: the existence of gender and SES inequalities in science education, and how these intersecting disparities hinder the involvement and achievement of low-class female students. The discussion emphasises the necessity of recognising intersectional factors to promote equitable educational opportunities, arguing that a nuanced understanding of historical and cultural contexts is essential for fostering social justice in science education and beyond.

Key Words: Intersectional Analysis, Educational Equity, Gender, Socioeconomic Status, Science Education

1. Introduction

Equity and social justice are persistent issues that have been discussed in societies worldwide from various perspectives. Despite numerous concerted efforts to address these challenges, achieving equality and justice remains an elusive goal, particularly in the realm of education. Breen and Jonsson (2005) suggest that educational inequality is a significant topic in education research because it is closely linked to obtaining educational qualifications and social status, and more importantly, reflects the broader societal inequality. There are certainly significant signs of progress in reducing inequality in education while more efforts still need to be made (Yang, Huang & Liu, 2014). From a social reproduction perspective, Bourdieu (1986) argues that children enter the education system with varying degrees and kinds of cultural capital transmitted from their families, resulting in unequal starting points. Compounding this, the school system reflects and prioritizes the cultural capital of the dominant class. As we zoom the picture to science education, Rezende & Ostermann (2018) have suggested that science education is considered to be a specialized form of socialization within a particular subcommunity that is inseparable from the social organization of scientists' activities, and thus involves a range of historical, cultural, political, economic, sociological, biographical, geographical, legal, and other factors. As they also address, inequality in science education plays the role of mirroring social inequality. Therefore, discussing inequalities in science education, specifically through an intersectional perspective is crucial for understanding and addressing broader social inequalities in education.

Science education in China, in this context both as a general subject and as a combination of physics, chemistry and biology, is plagued by deep-rooted gender and socio-economic status (SES) disparities. By analysing the intersections of these factors, this essay aims to shed light on the compounded impact of gender and SES inequalities, which often result in even greater disparities. Two critical questions that guide this discussion: (1) what evidence exists of gender and SES inequalities in science education in China, and (2) how do the intersectional inequalities of gender and SES impede low-class female students' involvement and achievement in science education? Given the historical and cultural factors contributing to such disparities, this essay argues that addressing the intersectional features of these inequalities is crucial for promoting equitable and just educational opportunities for all students in China, both in science subjects and beyond. This argument draws on theories of social reproduction, social inequalities, and intersectionality, as well as an examination of the historical context, policies, practices, and empirical evidence surrounding the dilemmas and challenges of these issues.

2. Addressing Inequality in Science Education in China: Challenges of Access and Inclusion

To look at educational inequalities generally, despite efforts to reduce educational inequality, evidence of disparities can still be found even within national educational policies. One example is the pathway to college, which includes three milestones in the post-compulsory education phase: gaining access to high school through the High School Entrance Examination (HSEE, also known as Zhongkao), determining the subject focus of liberal arts (history, geography and politics) or sciences (physics, chemistry and biology) through High School General Examination (HSGE, also known as Huikao), and gaining access to college through the College Entrance Exam (CEE, also known as Gaokao), are crucial steps in this pathway (Loyalka et al., 2017). Research indicates that disadvantaged students are less likely than advantaged students to achieve these milestones, resulting in a widening gap in college access (Loyalka et al., 2017). Another instance is the key-school policy which was established in the 1950s and divided China's public education system into key schools and regular schools. Lewin (1987) found the system of key schools in operation national, provincial, and municipal wide through competitive procedures which lead to additional resources and higher tertiary education transition rates are above students who attend “normal schools” (typically much money and more staff). According to Liu (2018), despite its "official abolishment" in the late 1990s, it resulted in widening gaps between key and regular schools. Additionally, local educational authorities commercialized limited access to key schools to generate funds for the development of the public education sector, resulting in intense competition for admission.

To look at the nature of science education generally in light of the challenges humanity faces, including global warming, sustainability, stability of the ecosystem and human wellness, it demands changes in human lifestyles, underscoring the need for universal education on science-related grand challenges (Tobin, 2015). To achieve this, science education programs must be accessible and relevant to all individuals, regardless of their gender, location, economic status, language proficiency, religion, or level of prior education (Tobin, 2015). However, this process has left most of the population aside with the fact of the underrepresentation of certain groups, such as women and the lower SES population, which raises questions about whether science education is prioritized equally for all individuals. Therefore, it is imperative to examine the factors contributing to the underrepresentation of these groups to ensure that science education is inclusive and accessible to all.

Unterhalter (2021) identifies that inequality is a multifaceted concept that presents definitional challenges in educational, political, economic, and social relationships. Although individuals share similarities and differences, the significance of these differences varies depending on the time and place, influencing educational experiences and outcomes. To address inequality, different methods of categorizing inequalities exist, including distributional arrangements (vertical inequality), the social and cultural construction of relationships between groups (horizontal inequality), and unequal processes (procedural inequality). Based on Unterhalter's (2021) categorization, gender can be considered a horizontal inequality, where deep-seated hatreds shape the treatment of female groups leading to exclusion, discrimination, and criminalization. SES can be categorized as a vertical inequality associated with an individual's ownership, distribution, and consumption of resources. These categorizations provide a framework for understanding how different types of inequality operate, enabling interventions to address them.

Science education is a field critical for economic growth and innovation; however, the disparities in educational opportunities and outcomes based on gender and SES are particularly pronounced. In

China, these inequalities are evident, hindering the country's ambitions to become a global leader in scientific and technological innovation. China recognizes the importance of science, with a slogan from the 1930s stating, "Science will save the country" (Lewin, 1987, p. 423). However, despite significant progress in science education, inequality remains a significant issue in all levels of education. School selection policies, educational gaps between rural and urban areas, gaps between genders, and other irrational policies were identified by Yang, Huang, and Liu (2014) as sources of educational inequality. Therefore, it is critical to address equity issues based on gender and SES, which will be critically discussed in the following sections.

3. Gender Inequalities in Science Education

This section explores the issue of gender inequality in science education, which is identified by Unterhalter (2021) as vertical inequality based on distributional arrangements. The competition for limited opportunities in the post-compulsory phase has favoured privileged individuals with higher SESs and males. Gender inequality in accessing elite higher education can be traced back to the influence of Confucian philosophy, which has historically oppressed women due to patriarchal social systems and limited legal rights (Lewin, 1987; Valutanu, 2012). Elite higher education institutions serve as resources and weapons in the struggle for economic and political hierarchy and dominance, contributing to the reproduction of class relations under the guise of neutrality (Bourdieu, 1973). Despite progress in narrowing the gender gap in science fields, persistent factors such as cognitive and motivational biases, gender-related stereotypes, and cultural biases continue to contribute to female underrepresentation in these fields (Wang & Degol, 2017).

From the perspective of cognitive and motivational biases, Mujtaba & Reiss (2013) suggests that boys tend to have more positive perceptions and confidence in science, while girls' aspirations in post-compulsory science subjects, particularly physics, are influenced by various factors such as teachers encouraging girls to conform to existing structures in science education that are not girl-oriented, gendered patterns in subject choice, gender-specific stereotypes about career options, and societal influences, family and social class differences. These factors not only contribute to the lack of diversity in science fields but also limit the potential of mathematically talented females who face cultural barriers, gender stereotypes, or misinformation. To address this issue, it is necessary to minimize these underlying elements by increasing the range of career choices that women perceive as feasible and harmonious with their skills, inclinations, and aspirations. Additionally, the general public perceives scientists as isolated and irrelevant to social problems, which may impact girls' identification with and aspirations in science. Therefore, policy, research, and practice should address the inequalities in girls' educational experiences in physics (Mujtaba & Reiss, 2013) in to promote girls’ positive experiences and aspirations in science.

Gender-related stereotypes also play a significant role in shaping students' identification with and aspirations in science. Science is often considered to be a masculine subject, and this alignment with masculinity can affect students' aspirations and identification with the subject (Mujtaba & Reiss, 2013). The study shows girls are more likely to agree that science is difficult, and they perform less outstanding at science. Additionally, the hidden curriculum of male students' dominant performance can also discourage female students' aspirations in taking challenges in science learning. In my own experience as a female student in science classes, the hidden curriculum of male students' dominant performance includes teachers mentioning "will any boys be interested in trying the difficult question", which discourages female students' aspiration in taking challenges in science learning. Pedagogically, it is important to make physics, as well as other science subjects, an enjoyable subject for all students to study regardless of their future intention in science.

Cultural biases play a significant role in shaping the aspirations of women in science. Despite efforts to promote gender equality in Chinese society, patriarchy still dominates, with men occupying dominant roles both in the family and in society. China's patrilineal family system reinforces the culture of valuing sons more than daughters due to perceived physical strength, social role, and family responsibility (Murphy, Tap & Lu, 2011). As a result, discriminatory and abusive behaviour towards girls is prevalent, as evidenced by high rates of gender-selective abortions, female infant mortality rates, and differential investment in girls' nutrition and health (Murphy, Tap & Lu, 2011). These biases limit the choices of mathematically talented females and contribute to the lack of diversity in science fields (Wang & Degol, 2017). Furthermore, women are more likely than men to prioritize family obligations over their careers and prefer work-centred lifestyles at lower rates than men (Eccles et al., 1999; Hakim, 2006). However, such biases ignore the fact that educating girls can have a positive impact on the education and health of their children and contribute to economic development through human-capital transmission (Doepke & Tertilt, 2009; Schultz, 2002). Thus, it is essential to address cultural biases that restrict the potential of women in science fields and promote education for girls. Not only is this crucial for gender equality, but it is also necessary for the betterment of society as a whole.

Gender inequalities in science education are a significant challenge globally. To achieve gender equality and create a more diverse and inclusive science workforce, it is crucial to address cognitive and motivational biases, gender-related stereotypes, and cultural biases and promote education for girls. Bourdieu (1987) notes that science can provide a route to social mobility and excluding women from science fields limits their opportunities and choices. As scientific advances continue, it is increasingly important for women to have access to science education to be active and empowered citizens.

4. Socioeconomic Status Inequalities of Science Education in China

Bourdieu (1986) posited that economic capital is the source of all other forms of capital which can be used in pursuit of other forms of capital, such as social capital and cultural capital. Socioeconomic status (SES) is a measure of an individual or group's social class that is determined by a combination of education, income, and occupation (APA, 2018; Brese & Mirazchiyski, 2013). Evaluating SES involves analyzing household income, earners' education, and family occupation (Gorad & See, 2018). However, the subjectivity and intersectional nature of SES make it mutable, particularly when economic advancement opportunities are provided in a society (Rubin et al., 2014). Given the complexity of defining and dividing SESs, for this discussion, it is generalized into high, middle and low in accordance with the concept of urban, rural-to-urban migrant and rural populations. While urban regions have their own hierarchical SES divisions, the gap between urban and rural regions in China is significant. As Zhang (2015) suggests, despite the rapid development of urban regions, some rural areas remain below the poverty line. Although the Chinese government has made efforts to increase public investment in education since 1978, education inequality still persists between urban, rural-to-urban migrant and rural populations, in regard of income disparity, nutrition, institutional barriers, education quality and different parenting styles (Zhang, 2015). According to Zhang's (2015) study, the education performance of rural children and rural-to-urban migrants in is significantly lower than their urban counterparts which leads to significantly lower enrolment rates compared to their urban and peers. Factors that impact students' science aspirations and achievements includes the opportunity of accessing high quality education resource and career options.

As for the accessibility of high-quality education resources, it is highly competitive in the Chinese context. A significant disparity in educational expenditures is witnessable across different regions in China. According to the Ministry of Education of the People's Republic of China (2022), annual educational expenditures in Shandong (238.7 billion CNY) and Guangdong (379.34 billion CNY) provinces are much higher compared to underdeveloped regions like Qinghai (23 billion CNY) and Tibet (29 billion CNY). As a result, some schools in underdeveloped regions may struggle to provide basic resources such as tables, chairs, and multimedia equipment while schools in developed regions could equip with genetic sequencing equipment, atomic force microscope, or astronomical telescopes. The disparities are so significant that it requires specific attention to be paid to this issue. Additionally, in regard to science education, better economic development makes high-quality resources such as qualified teachers, funding and science equipment to allocate in these schools. Consequently, students in more developed urban regions will have more opportunities to access better learning resources and higher learning quality.

The economic capital of parents plays a significant role in determining their children's access to high-quality education (Crosnoe & Cooper, 2010). Children from enjoy an edge in obtaining educational credentials due to their families' financial means (Broer, Bai & Fonseca, 2019). Moreover, the privileges of success in science are enjoyed by students from higher socioeconomic backgrounds, including early enlightenment from well-educated parents, additional expenses on extra-curricular science projects and activities, the chance of entering a "key point school," the likelihood of studying overseas (with expenses for both living and learning a foreign language to meet enrolment requirements), access to the most advanced technology and equipment, and higher chances of being employed by top-notch institutions. After two years of implementing the "double reduction" policies, parents' anxiety about reducing necessary tutorial sessions has increased, while some after-school tutorial institutions may be disguising themselves as private home tutors, charging higher fees than before, to circumvent the formal ban on their operations (China Education News Network, 2022). This further highlights the significant impact of economic status on educational opportunities and success in science and other subjects. To address this issue, policy interventions are necessary to improve access to high-quality education for students from disadvantaged backgrounds, especially in underdeveloped regions where access to resources is limited. This can help to promote equity in education and foster a more diverse and inclusive scientific community.

Education expenses during the post-compulsory phase are considered enormous, especially for rural impoverished families or students that have the plan to study overseas. As Loyalka et al. (2017) suggest, students who come from underprivileged backgrounds in China might encounter challenges in affording the tuition fees for academic high schools or colleges, as these fees often surpass their families' yearly income. Additionally, the overall tuition and other costs of science subjects are more expensive than liberal art subjects. Furthermore, the acceleration of globalization has led to increased internationalization efforts in of individuals, institutions, and the nation to stay competitive in a rapidly changing world (Han, 2022). Enterprises and academic institutions in China tend to give priority to candidates with overseas study experience when it comes to science career opportunities, which is seen as a significant incentive for Chinese students to pursue their studies abroad (Liu, 2017). For students whose families cannot support the high expense of overseas studies, their academic careers will be eliminated not by their academic performance but by the serials of consequences of their household economic status. These factors can influence the educational decisions of low-SES families and students' science choices and performance, with implications for social mobility and economic opportunities.

5. Intersectional inequalities of science education in China

Science education in China is subject to various forms of inequality and disadvantage that intersect and create obstacles to the participation and success of marginalized individuals and groups. Inequalities can amplify each other, which is one feature that intersectionality, which explores the intricate and cumulative manner in which the consequences of various forms of discrimination combine, intersect, or overlap, particularly in the encounters of individuals or groups that are marginalized (Crenshaw, 1989). Unterhalter (2021) defines intersectionality as a concept that allows us to acknowledge how belonging to different social groups can make individuals susceptible to different types of biases which could serve as a valuable approach for identifying how various forms of inequality intersect and impact individuals in different ways, such as the degree of inequality, the group affected, and the way it manifests. An intersectional approach is necessary to tackle the overlapping inequalities and promote more inclusive and diverse scientific communities, which involves analysing social issues more comprehensively and building coalitions among different groups to challenge and transform the current state of affairs (Gillborn, 2015).

Western research has long focused on race as a major factor in educational inequality, while in the context of China, where the concept of race is unitary in most state schools, social divisions such as gender, socioeconomic status, ethnicity, geography, and disability play more significant roles. Gender and SES inequalities, as discussed earlier, are key factors that influence science participation and performance. For example, rural women face unique challenges in accessing science education, which can result in a vicious cycle of low science literacy in their families and communities. Hannum (2003) suggests that as the cost and economic value of child labour rise, impoverished families are more likely to deny their children, especially girls, the right to attend compulsory education. Loyalka et al. (2017) identify several factors that impact disadvantaged students' decisions to continue in college, including academic performance, tuition costs, and the teaching quality of rural schools.

In male-dominated communities, girls' values are often suppressed, particularly when it comes to education. For example, when families are facing poverty and have to consider the returns on investment in schooling, boys are often privileged over girls due to the traditional differentiation of the value of such returns (Loyalka et al., 2017). This results in a strong incentive for parents to prioritize their sons in decisions about children's schooling, even if it means sacrificing their daughters' opportunities for education (Hannum, 2003). Additionally, the prevalent patrilocal marriage culture often means that sons are expected to cohabit with their parents after marriage, providing long-term security, while daughters are expected to marry out of the family as soon as possible and bring back a bride price. In this context, the education of a son is seen as a necessary investment, while the expected lack of access to the earnings of adult daughters provides an economic incentive for poorer families to avoid the costs associated with educating girls (Hannum, 2003). The same norm also applies to females from other socioeconomic statuses, even though they may not be as noticeable or distinct. This means that similar societal expectations and biases apply to girls from various backgrounds that might limit their opportunities and choices, particularly in education.

Reiss (2014) suggests that the aims of science education include producing scientific literacy, raising public understanding of science, nurturing vocational or other benefits, and producing future scientists. However, in rural China, it is difficult to achieve even the most fundamental aims of learning science. The lack of basic science literacy can be very harmful to rural girls' constitution of a flourishing life and that of others, which is identified by Reiss (2014). For instance, a lack of knowledge in biology and health can lead to a higher incidence of young age pregnancy, dangerous abortion behaviors and miscarriages, while a lack of earth science knowledge might result in superstitious practices such as burning incense and offering tributes to spirits wishing for rain. Illiteracy in science can have significant implications for household well-being, underscoring the importance of addressing intersectional inequalities that prevent rural women from pursuing science education. From a Bourdieu (1987) perspective, we view students' engagement with science as a type of activity that is created by the dynamic relationship between their predispositions, resources, and the educational environment, and that is expressed through their purposeful and adaptive actions.

Thus, in the context of intersectional inequality experienced by rural women due to their gender and SES, it aligns with Archer and DeWitt's (2016) interpretation of intersectionality as a means of comprehending how different forms of inequality or disadvantage can combine and form barriers that are not typically recognized using conventional methods of thinking. This concept of intersectionality also applies to how injustices and power dynamics operate within the field of science, leading to patterns of exclusion and oppression.

6. Summary

In this essay, I have explored the issue of inequality in education, with a particular focus on science education, by examining it through various theoretical lenses such as social reproduction, inequality, and the aims of education. I have looked at inequality in education and science education horizontally through SES, vertically through gender, and through an intersectional perspective through the interchange of the two.

The issue of gender inequality in science education highlights the impact of cognitive and motivational biases, gender-related stereotypes, and cultural biases that limit women's opportunities and aspirations in the field. These factors lead to a lack of diversity and inclusion in the science field, making it difficult for women to access and succeed in science education which leads to a lack of diversity and inclusion in the field. SES inequality emphasizes the impact of family SES on students' science opportunities and achievements, especially for low-SES backgrounds who struggle with the high costs of tuition fees, extra-curricular activities, and accessibility to laboratory equipment associated with pursuing high-quality science education. The rural-urban divide in China adds another layer of challenge to the SES division of society, limiting educational funding and hindering the development of well-equipped laboratories and qualified teachers.

An intersectional perspective highlights the unique challenges faced by rural women who face the interchange of dual identities, with science education being particularly challenging. Such challenges include the strong influence of a patriarchal system, limited access to resources and support, and cultural expectations that prioritize traditional gender roles over education and social identity. To address these intersectional inequalities and promote more inclusive and diverse science education in China, it is important to address gender biases and stereotypes, improve access to resources and opportunities, recognize and support the unique challenges faced by rural women in science education, and promote their inclusion and success in the field. Greater recognition and support for the unique challenges faced by rural women in science education, and a commitment to promoting their inclusion and success in the field.

In conclusion, intersectional inequalities are a significant issue in science education in China, particularly for rural women. Addressing these intersecting inequalities is critical to creating more opportunities for underrepresented groups to succeed and promoting greater inclusion and diversity in the field. Discussions on intersectional inequalities of females in other SES contexts will also be valuable in carrying forward the potential value of viewing inequality through an intersectional lens.

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