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Gender differentiated teaching in STEM fields for Chinese secondary school students

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Abstract: *STEM fields play a pivotal role in both national economies and university advancements. Nonetheless, the gender gap persists between male and female STEM students, posing a significant concern, as around 66% of STEM students are male. This disparity has adverse implications for women's societal status in the long term, particularly within the realm of secondary school education. Gender inequalities in STEM education exhibit a closer association with secondary school years rather than college years. Studies scrutinizing the gender disparity from a high school perspective often emphasize gender norms and attitudes. However, recent investigations into the impact of family, educators, and peers on secondary school learning experiences have embraced a social-cognitive standpoint. In China, the choice of a university major is heavily shaped by the student's secondary school curriculum, which distinguishes between arts and scientific subjects. Predominantly, male students opt for STEM-focused courses. This study is designed to examine gender discrepancies among students in STEM fields and ascertain effective differentiated teaching approaches that could enhance girls' engagement and interest in these domains. The study's research inquiries encompass the influence of gender-specific teaching in STEM fields on academic accomplishment and interest in pursuing STEM-related professions for both male and female students. Furthermore, the study aims to gauge the impact of STEM educators' attitudes and beliefs on their implementation of gender-specific teaching methodologies. Ultimately, the investigation aims to pinpoint the most efficacious gender-specific teaching practices within STEM fields.*

Keywords: *Motivation, STEM education, Second school students, Gender differentiated teaching*

1. Introduction

Science, technology, engineering, and mathematics (STEM) disciplines are viewed as a means of sustaining the national economy in China and elsewhere. The fundamentals of STEM education are essential to the university and career development of students. Today, more women than ever before earn degrees in science and engineering; however, women with high mathematical ability choose non-STEM fields more frequently than men with comparable mathematical ability [1]. Despite the popularity of STEM disciplines in Taiwan, the gender disparity between male and female STEM pupils remains a critical issue that must be addressed. The Ministry of Education of Taiwan reports that approximately 66% of STEM students are male [2]. Women's long-term social status is adversely affected by gender disparities in STEM fields. Understanding the factors that influence the STEM career intentions of male and female pupils is therefore essential for resolving the gender disparity among STEM professionals; it is also one of the most important aspects of secondary school education. This is why it is essential to examine gender-specific instruction in STEM fields. The educational experiences of pupils throughout birth and adolescence aggravate gender gaps in STEM education. Studies have shown that gender inequalities in STEM education are more closely related to secondary school years than to college years [3].

According to Sadler, Sonnert, Hazari, and Tai (2012), females' interest in STEM fields decreased significantly from 15.7% to 12.2% while it stayed consistent for boys at around 39% in high school. Additionally, research on the gender gap from the perspective of a high school has often concentrated on gender norms and attitudes [4]. As a result, several recent research on the influence of family, teachers, and peers on secondary school learning experiences have embraced a social-cognitive viewpoint.

1.1 Theoretical Framework

Gender-specific Many different theoretical stances, pedagogical models, and conceptual frameworks

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are used in STEM classrooms. This framework describes how using a differentiated pedagogical approach can help reduce the gender gap in STEM fields.

The Goal Congruity Theory is a crucial theoretical framework for understanding the mutual influence of one's social function and internal drive in this context. There may be fewer women working in STEM professions because women are less likely to believe they can make a meaningful contribution to society through these careers. This argument may help explain why fewer women than men work in science, technology, engineering, and math (STEM) fields [5].

The DI framework, which emphasises tailoring instructional strategies to meet the needs of individual students, is yet another influential theoretical perspective [6]. This approach seeks to establish an inclusive learning environment that fosters the achievement of students of both sexes by accounting for differences in learning styles, interests, and motivations between the sexes.

The Critical Mass Theory sheds light on why it is crucial to promote gender parity in STEM professions. According to this hypothesis, having a particular number of women on a board or in a group might alter its dynamics and its results [7]. More women in STEM professions and classrooms can improve outcomes and promote gender equality, as this idea explains.

The ERASMUS+ botSTEM project offers a fresh viewpoint on the topic of gender diversity in STEM classrooms. The botSTEM project uses a curriculum that is inclusive of both genders, and it centres on robotics, engineering design methods, and inquiry-based learning [8].

The gendered dynamics of LMS adoption and use in STEM and non-STEM fields are also illuminated by Manzanares [9]. The research revealed that teacher and student use of learning objects in LMS varied by both experience and gender. Teachers and students, especially those without STEM backgrounds, need access to technological training in order to close the technology gap and its indirect links to the gender gap and the digital divide.

The research of Catalán shed light on how different students of different sexes react to teachers' displays of authority, motivation, and defiance in the context of physical education [10]. Across the board for self-determination theory-related variables, girls reported more maladaptive outcomes than boys, highlighting the need to reduce controlling behaviours in teaching for girls.

1.2 The Gender Differentiated Teaching

Gender-differentiated teaching and learning is the practise of adapting educational strategies and approaches to suit the varied requirements and learning patterns of girls and boys. This strategy recognises that boys and girls frequently have different interests, preferences, and learning styles, and aims to create a more equitable and inclusive learning environment that promotes the success of all students. According to the Harvard Graduate School of Education, gender-differentiated teaching and learning strategies may include activities that promote collaboration and communication, self-directed learning opportunities, and the use of role models and mentors to encourage interest and engagement in different subjects [11].

2. Gender Disparities in STEM Education and Ethics Concern

There is a wide variety of approaches one can take to improve their fitness. Athletes tailor their strategies to the specific demands of their sports.

2.1 Gender Gap in STEM: Cultural and Societal Influences

China is not alone when it comes to the gender gap in STEM professions. Taking into account social conventions, cultural influences, and educational practises, the gender gap in STEM areas persists despite the country's success in this area.

The gender gap in STEM is caused in great part by the social pressure to conform to traditional gender roles. According to Chan (2022) research, women who have low self-efficacy tend to be disinterested in and unmotivated by STEM occupations and fields. Students who agreed with gender stereotypes were more likely to show variations in self-perception and aspiration on tests of interest in and pursuit of STEM careers.

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2.2 Cultural Norms and Role Models

Culture and society play an undeniable role in explaining the gender gap in STEM fields. In China, a student's eventual choice of college major is heavily influenced by the courses they took in high school. Due to the country's stringent university admittance criteria, the arts and sciences are taught separately in China's secondary schools. In secondary schools, boys tend to choose more male-dominated STEM-focused majors and electives [12].

The gender gap in STEM fields is exacerbated by educational practices that disproportionately benefit male students. While the public conversation about women's underrepresentation in STEM fields is well underway in the West, it is just getting started in China. Racial microaggressions (RMAs) are common in STEM classrooms, student organizations, and interactions with faculty and staff, according to research by Lee et al. (2020). RMAs affect students of colour across all three levels, but they have an outsized impact on Black students pursuing STEM degrees. This highlights the importance of coordinated efforts to combat racism on college campuses among administrators, academic professionals, faculty, and students at the institutional, collegiate, and individual levels.

The gender gap in STEM disciplines is exacerbated by current educational procedures and laws, which in turn are exacerbated by sociological and cultural issues. The gender gap in China's STEM fields has been linked to the country's educational institutions and practises, which have been said to favour male students over females [13]. This bias is reflected in the course materials, methods of instruction, and even parental expectations.

2.3 Communication Skills and Collaboration

According to Sorby, "first-year female engineering students with poorly developed spatial skills who receive spatial visualisation training are more likely to stay in engineering than their peers who do not receive training" (2009). Seventy-seven percent of the female engineering majors who took a spatial-visualization course and scored poorly on an initial assessment of spatial skills were either still in school or had already graduated. The percentage of women who continued their education or graduated from the engineering school was significantly lower among those who did not take the spatial-visualization course.

3. The Benefits of Gender-Differentiated Education

The importance of gender-specific pedagogies in the STEM fields cannot be overstated. One important factor is that they can be modified to suit the needs of both male and female students [14]. Both Vygotsky's social constructivist theory and Bandura's social cognitive theory recognise that students learn in different ways and at different paces. Educating with an eye toward gender differences benefits students of both sexes [15].

3.1 Promoting Equitable Participation and Achievement

It's worth noting that providing pupils of both sexes with a curriculum tailored to their identities has the potential to boost their interest in and success in STEM disciplines. Women's participation and performance in STEM (science, technology, engineering, and mathematics) classes have been shown to be subpar [16]. Gender-diverse approaches, which take into account the fact that male and female pupils learn in different ways, can help close this gap.

3.2 Preparing Students for the Workforce

Student collaboration and problem-solving skills might benefit from gender-based pedagogical approaches as well. The American Society for Engineering Education revealed that engineering teams performed better when teachers took into consideration students' innate gender disparities [17]. The MERIT kit, which is based on social cognitive theory and social constructivism, was used to enhance traditional classroom training.

3.3 Preparing Pupils for the Profession

More than ever before, schools can afford to offer courses tailored to each gender. Experts from many

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professions sometimes collaborate in practice to find solutions to difficult situations. Educators can do a better job of preparing their pupils for the profession if they take into account the differences between the sexes.

The obstacles to implementing gender-based STEM curriculum reform must be acknowledged. The views and ideals of teachers, the availability of resources, and the cultural and societal norms of the school's community can all have an impact on how effective these approaches are.

4. Conclusion

This study investigates gender-specific STEM education in Chinese secondary schools, examining reasons for low female participation, notably cultural norms and stereotypes. It employs comprehensive methods, emphasizing secondary school's role in shaping the gender gap and advocating cultural change alongside gender-specific education. While insightful, the study's reliance on secondary sources and regional focus restrict its applicability. It suggests future research should consider intersectionality and classroom dynamics for a more holistic approach to addressing gender disparities in STEM.

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