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A STUDY ON ENHANCING FEMALE HIGH SCHOOL STUDENTS' STEM CAREER AWARENESS THROUGH CAREER EDUCATION IN JAPAN

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ABSTRACT

The persistent underrepresentation of women in Science, Technology, Engineering, and Mathematics (STEM) fields remains a global concern despite sustained policy efforts to promote diversity and inclusion. Although female educational attainment has increased worldwide, participation in engineering and technical STEM pathways continues to lag. Japan presents a particularly instructive context: while female students perform strongly in mathematics and science, women remain underrepresented in engineering-related higher education and research careers. Despite national initiatives promoting women's participation in STEM and the institutionalisation of career education in secondary schooling, gender disparities persist.

This study examines how career education relates to female high school students' awareness of STEM careers in Japan. Using a mixed-method research design, a 5-point Likert-scale survey and open-ended questions were administered to 244 female students from three public high schools in the Kyushu region. Quantitative data were analysed descriptively, and qualitative responses were examined thematically.

The findings indicate that limited occupation-specific knowledge and concerns about workplace environments contribute to hesitation in considering STEM career pathways. Even in schools offering structured STEM programmes, students often lack concrete understanding of professional roles, required competencies, and career trajectories. The results suggest that STEM coursework alone does not necessarily facilitate career meaning formation. Rather, the alignment between disciplinary learning and structured career guidance appears critical in supporting informed career construction.

By highlighting how STEM education and career education may operate in parallel rather than integrative modes, this study contributes to international discussions on gender disparities in engineering and related fields. The findings underscore the importance of strengthening career education mechanisms during secondary schooling to support more diverse and inclusive participation in STEM over time.

Keywords: Stem education, career education, female high school students, career awareness, Japan

1 INTRODUCTION

Gender disparities in STEM participation remain a global concern despite increasing levels of female educational attainment [1][2]. Across Organisation for Economic Co-operation and Development (OECD) countries, women continue to be underrepresented in engineering, Information and Communication Technology (ICT), and other technical STEM fields. In response, governments and educational institutions worldwide have introduced initiatives aimed at broadening participation. These include expanding STEM-focused curricula, integrating engineering practices into science education frameworks, developing outreach programmes to encourage girls' engagement in science and technology, and strengthening career guidance systems to support informed educational and occupational decision-making [3][4][5].

Despite these policy efforts, gender imbalances in STEM pathways persist. Research suggests that participation in STEM coursework alone may be insufficient to foster long-term STEM career aspirations. Career development theories emphasise that occupational choices are shaped not only by academic performance, but also by self-concept, perceived belonging, social expectations, and culturally embedded images of particular professions [6][7]. Informational initiatives or curricular exposure alone

may therefore be insufficient if students do not perceive meaningful alignment between their educational experiences and future identities.

Within this broader international context, Japan presents a particularly instructive case. Japanese girls consistently demonstrate strong performance in mathematics and science assessments; however, women remain underrepresented in STEM higher education and research careers [8]. National responses have included policies promoting gender equality in science and technology, outreach initiatives encouraging girls' participation in STEM, and institutional programmes such as the Super Science High School (SSH) scheme to strengthen science and technology learning environments [9]. At the same time, career education is formally embedded within Japanese secondary schooling through structured guidance systems that emphasise self-understanding, career planning, and the development of transferable competencies rather than occupation-specific preparation [10][11].

Nevertheless, while STEM enhancement initiatives and career education policies coexist within the Japanese secondary system, their interaction has received limited empirical examination. Existing studies have tended to focus on policy implementation or general competency development, rather than investigating how high school career education may shape female students' awareness of STEM career pathways during the critical stage of academic tracking and decision-making. This gap underscores the need to examine how career education and STEM learning experiences intersect in influencing female students' career perceptions within the Japanese high school context. Against this backdrop, this study investigates the current state of STEM career awareness among Japanese female high school students and examines how career education relates to this awareness. Focusing on three public high schools in the Kyushu region with varying degrees of integrated STEM education, the study seeks to identify key factors shaping female students' understanding of STEM careers. By clarifying these factors, the study aims to contribute to discussions on how STEM coursework and career education may be more effectively aligned to support greater female participation and diversity within STEM fields.

2 LITERATURE REVIEW

Gender disparities in STEM participation remain a global concern despite increasing female educational attainment. Although overall educational attainment among women has improved, participation in engineering and ICT-related STEM fields remains comparatively low in many countries. In Japan, women represent a particularly small share of STEM researchers and technical professionals [12].

Research consistently identifies high school as a critical stage for career formation. Longitudinal studies demonstrate that interest in mathematics and science develops early and that career expectations often crystallise before university entry [13][14]. Gender differences in occupational aspirations are already visible during adolescence. In systems such as Japan's, where students select academic tracks during high school, limited awareness at this stage may narrow future STEM opportunities. In Japan, career education is formally embedded within secondary schooling and emphasises transferable competencies, self-reflection, and career planning rather than detailed occupational specialisation [15]. At the same time, initiatives such as the Super Science High School (SSH) scheme aim to strengthen STEM learning experiences through enhanced science and technology curricula [16]. However, the extent to which STEM coursework and structured career education are aligned in fostering STEM career awareness remains insufficiently examined. This gap underscores the need to examine how high school career education interacts with STEM learning experiences to influence female students' career perceptions within the Japanese context.

3 RESEARCH METHODOLOGY

3.1 Research questions and method of inquiry

This study aims to identify the key factors within high school career education that influence female students' awareness of STEM careers. To address this objective, the study investigates the following research questions: a) What is the current level of awareness of STEM careers among Japanese female high school students? b) What misconceptions or biases do Japanese female high school students hold regarding STEM careers? c) What aspects of high school career education shape female students' awareness and understanding of STEM careers?

This study adopts a mixed-method research design and focuses on three public high schools in the Kyushu region of Japan. Data were collected through an online questionnaire survey, which effectively gathered female students' perceptions, understandings, and attitudes toward STEM careers.

3.2 Research design and implementation

3.2.1 School Context

To examine whether female students' STEM career awareness varies across institutional contexts, three Japanese high schools (F, K, and M) representing different levels of STEM implementation were purposively selected. F High School is a general academic school without a formal STEM programme. K High School runs a STEM programme in which students study a shared topic at different levels depending on their interest. M High School, designated as a Super Science High School (SSH), integrates STEM across subjects throughout all three years. These schools represent low (F), moderate (K), and high (M) levels of STEM implementation.

3.2.2 Participants and Data Collection

Data were collected through an anonymous online questionnaire administered to female students in the three schools. A total of 244 valid responses were obtained (F: 43; K: 121; M: 80). Participation was voluntary, and institutional permission and informed consent were secured.

3.2.3 Measures

The quantitative scale employed 5-point Likert items (1 = Not at all familiar; 5 = Very familiar) to assess perceived familiarity with STEM-related careers. Questions for each of the four STEM fields were developed based on the framework provided by the U.S. Bureau of Labor Statistics (BLS), which introduces STEM careers across eight aspects: job types, work duties, required skills, required education, average income, job benefits, learning opportunities, and sources of career information. The same item structure was administered across four subject domains—science, technology, engineering, and mathematics. Table 1 presents the structure of the scale using science as an example.

Table 1. Example Structure of the STEM Career Awareness Scale (Science Domain)

Dimension	Example Item	Scale
Job Types	I have a good understanding of the types of jobs in science-related careers.	1-5
Work Duties	I have a good understanding of the work duties in science-related careers.	1-5
Required Skills	I understand the skills required in science-related careers.	1-5
Required Education	I understand the education required in science-related careers.	1-5
Income	I understand the average income in science-related careers.	1-5
Benefits	I understand the benefits in science-related careers.	1-5
Learning Opportunities	I have opportunities to learn about science careers.	1-5
Information Sources	I know where to find information about science careers.	1-5

Note. The same structure was applied to technology, engineering, and mathematics.

The second component consisted of open-ended questions designed to explore students' perspectives on gender and STEM careers. These questions are summarised in Table 2.

Table 2. Open-ended Questions

Theme	Question
Gender Perceptions	Do you think STEM jobs are more suitable for men or women? Why?
Career Interest	Would you like to work in a STEM-related job in the future? Why?
Challenges for Women	What challenges do women face in STEM careers?
Information Availability	Does your school provide enough information about STEM careers?
School Support	How should schools better support students' understanding of STEM-related jobs?

3.2.4 Data Analysis

Quantitative data were analysed using descriptive statistics (means and standard deviations) and between-school comparisons to examine differences in STEM career awareness across institutional contexts. Qualitative responses were analysed using inductive thematic analysis. Open coding was first conducted to identify recurring ideas, followed by category refinement and cross-school comparison to identify thematic patterns across participants.

4 RESEARCH FINDINGS AND DISCUSSION

4.1 Insufficient Career Information and STEM Career Intentions

As illustrated in Figure 1, female students across all three high schools demonstrate relatively low levels of STEM career awareness. Even in M High School, which offers a structured three-year STEM programme, awareness levels remain modest. This suggests that participation in STEM coursework alone does not necessarily translate into explicit career understanding. Figure 2 further indicates that low awareness is accompanied by limited career intention. A substantial proportion of students respond "No" or "I don't know" when asked about pursuing STEM careers. Open-ended responses frequently cite insufficient knowledge of occupational roles, required competencies, and career pathways. Importantly, as shown in Figure 3, most respondents do not explicitly endorse the view that STEM careers are inherently gendered. This suggests that hesitation toward STEM pathways may not primarily stem from overt gender stereotyping, but rather from informational gaps and uncertainty regarding career trajectories. These findings align with Social Cognitive Career Theory [17], which emphasises the role of occupational information and outcome expectations in shaping career interest. Without explicit linkage between classroom learning and concrete career knowledge, disciplinary participation may not translate into sustained career intention.

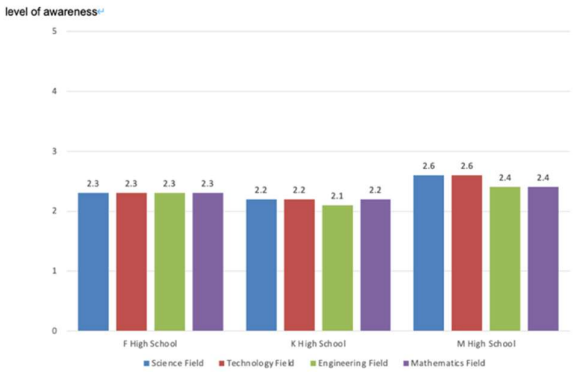

Figure 1. STEM career awareness across three high schools
Note: Scale ranges from 1 (Not at all familiar) to 5 (Very familiar)

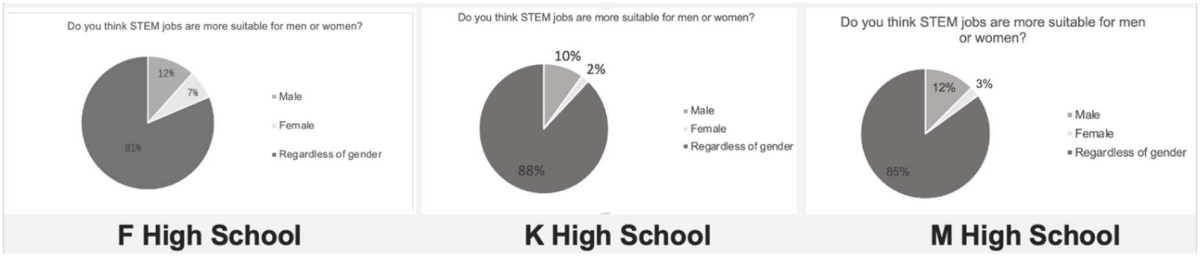

Figure 2. Female Students' Intention to Pursue STEM Careers

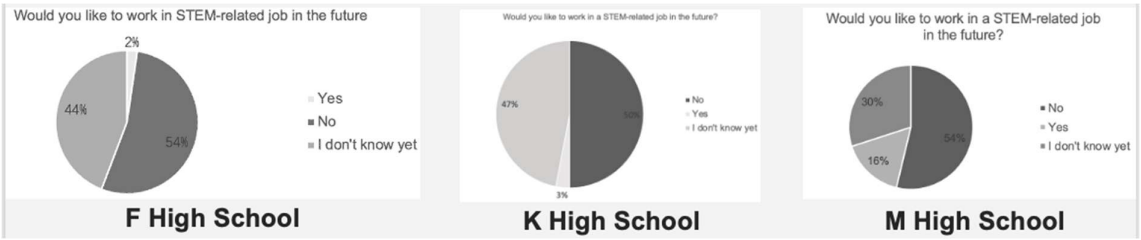

Figure 3. Female Students' Perceptions of Gender Stereotypes in STEM Careers

4.2 Perceptions of Workplace Environment as a Psychological Constraint

Beyond informational gaps, qualitative responses reveal a second dimension influencing STEM career awareness: perceptions of workplace environments. Many female student's express concerns regarding potential social isolation and insufficient support for maternity or childcare in STEM-related professions. While this study does not measure psychological constructs directly, these perceptions may contribute to hesitation in considering STEM pathways. Correll [18] argues that occupational aspirations are shaped not only by performance but also by socially constructed expectations and identity compatibility. Even in the absence of explicit discrimination, students may adjust their aspirations if they anticipate limited belonging or support within a professional field. Interestingly, although Japan has implemented various gender equality initiatives and workplace reforms, student responses suggest that awareness of these developments remains limited at the high school level. This indicates a potential disconnect between macro-level institutional progress and students' micro-level career perceptions. Accordingly, career education may need to address not only occupational descriptions but also realistic representations of workplace structures and support systems. Providing evidence-based and balanced depictions of STEM work environments could help reduce uncertainty rooted in incomplete or stereotyped images.

4.3 Structural Alignment Between STEM Learning and Career Education

The findings must also be interpreted within the institutional framework of Japanese secondary education. Career education in Japan emphasises transferable competencies, self-reflection, and autonomous life planning rather than occupation-specific preparation. This competency-based orientation reflects broader reforms prioritising adaptability in a rapidly changing labour market. At the same time, STEM enhancement initiatives such as the Super Science High School (SSH) scheme aim to strengthen disciplinary learning environments. However, as suggested by the relatively low awareness levels observed in Figure 1, strengthened STEM coursework does not automatically produce explicit STEM career understanding. This observation is consistent with OECD, which emphasises that career guidance systems are most effective when educational experiences are intentionally connected to occupational pathways. Within a framework that prioritises general competencies and school autonomy, structured mechanisms linking STEM coursework to concrete career exploration may remain underdeveloped. The combined evidence from Figures 1–3 and institutional analysis suggests that female students' STEM career awareness is shaped by three interrelated dimensions: a) Access to concrete and structured STEM career information. b) Perceptions of workplace culture and anticipated belonging. c) The degree of alignment between STEM coursework and career education. These dimensions indicate that disciplinary exposure alone is insufficient. Instead, systematic integration of career guidance and STEM learning may be necessary to support more informed and confident career exploration among female students.

5 CONCLUSIONS

This study examined Japanese female high school students' STEM career awareness, intentions, and workplace perceptions across three secondary schools with varying levels of STEM provision. The findings indicate that overall STEM career awareness remains limited, even in schools offering structured STEM programmes. While explicit gender stereotyping appears relatively weak, many students report uncertainty regarding STEM career intentions, often citing limited knowledge of occupational roles, required competencies, and career pathways. Concerns about workplace culture and anticipated gender-related challenges further contribute to hesitation in considering STEM-related professions.

Importantly, these findings suggest that the central issue does not lie in the absence of STEM exposure or formal career education. Japan has implemented STEM enhancement initiatives and institutionalised career education frameworks within secondary schooling. However, the coexistence of these structures does not automatically ensure the formation of concrete career meaning. STEM education primarily cultivates disciplinary knowledge and technical competencies, whereas career education is designed to support reflection on occupational identity, workplace expectations, and long-term life planning. When these domains operate in parallel without intentional integration, students may acquire STEM knowledge without translating it into viable career consideration. The results therefore point to a structural alignment issue rather than a policy vacuum. Career education in Japan emphasises transferable competencies and self-reflection yet may not consistently provide occupation-specific

exploration of STEM pathways. Without explicit mechanisms linking STEM learning experiences to professional contexts, students may struggle to envision themselves within STEM-related communities. Within the broader context of persistent gender disparities in engineering and technical fields, this distinction is significant. Expanding access to STEM coursework alone may increase participation, but fostering diversity and inclusion requires supporting the processes through which students construct career meaning. Strengthening the alignment between STEM learning and structured career guidance at the secondary level may contribute to more informed career exploration among female students and, over time, to more inclusive participation in engineering and related STEM fields. This alignment may be operationalised through the integration of career-relevant contexts within STEM instruction, such as exposure to professional practices, interaction with role models, and structured reflection on career pathways. While situated in Japan, these findings may also be relevant to other educational systems where STEM learning and career guidance operate in parallel rather than as integrated processes.

6 FUTURE RESEARCH AND LIMITATIONS

This study has several limitations. First, it focuses on three public girls' high schools in the Kyushu region, which may limit generalisability. Second, the analysis relies primarily on descriptive statistics, and the findings should therefore be interpreted as indicative rather than statistically generalisable. Third, career awareness is measured through self-reported familiarity, which may not fully reflect students' actual understanding. Finally, although qualitative responses were analysed thematically, the analysis did not employ a fully systematic coding procedure, limiting transparency. Future research could adopt inferential statistical methods and more systematic qualitative approaches to better examine the development of STEM career awareness and explore how structured career-related activities (e.g., workplace exposure, role models, and reflective tasks) can be integrated into secondary STEM education.

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