The Perceptions of Prospective Japanese Science Teachers on Female Students' Participation in STEM Subjects

Marvin ASIEDU [*1], Manabu SUMIDA[*1]

Faculty of Education, Ehime University

Abstract

The researchers identified the important role of teachers/facilitators in holistic development and decision-making in the life of students at schools. This compelled the researchers to investigate and understand the perception of Japanese prospective science teachers about female students' interest and participation in STEM (Science, Technology, Engineering, Mathematics) subjects. Therefore, this study aimed to identify and understand the actual baseline situation of Japanese prospective science teachers' perception and impact concerning female students' STEM education participation. A descriptive survey method was adopted for this study. Questionnaires were used as the instrument for data collection. The sample group included 41 Japanese prospective science teachers from various faculties at a national university. The study's findings indicated that the prospective science teachers seem to perceive female students to have low interest in STEM subjects even though their performance is almost the same as that of male students.

Keywords: STEM subjects, prospective Japanese science teachers, perceptions, female students participation, students' interest and performance

INTRODUCTION

STEM (Science, Technology, Engineering, Mathematics) education is concerned with teaching students the ability to integrate science and mathematics knowledge with technology and engineering to solve real-life problems in society. A major goal of STEM education has been to produce creative, diverse, and innovative problem solvers that will bring complex knowledge and skills to the evolving workforce (White, 2014; U.S. Department of Education, 2021). STEM education has wide entrepreneurship opportunities. In this era of unemployment in most parts of the world, only STEM education can assure one of a job or a source of income for a comfortable living. Due to this, many developed countries have enforced a high degree of science and technology education to boost their industrialization which has positively affected their economy.

Globally, the number of women in science, technology, and engineering is growing, yet men continue to outnumber women, especially at the upper levels of these professions. In elementary education, all the girls and boys take math and science courses equally. Yet fewer women than men pursue these majors in high schools and universities. Women's representation in science, technology, and engineering declines further at the graduate level and yet again in the transition to the workplace.

Over time, more females have entered STEM occupations. The percentage of women in STEM has slightly increased. A report by the World Economic Forum's Global Gender Gap Report 2021, indicated in the figure below shows women in selected STEM occupations from 1960 to 2021.

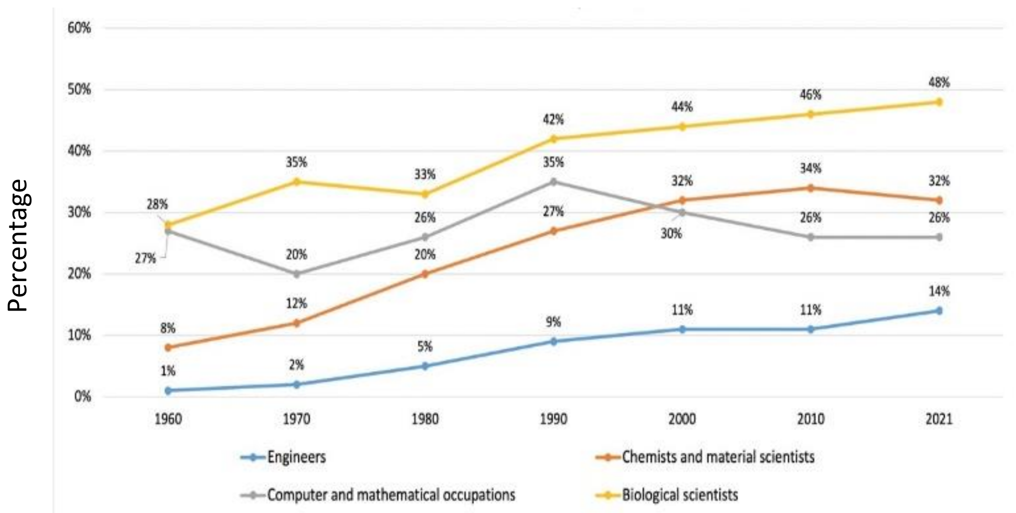

Figure 1. Women in selected STEM occupations from 1960 to 2021

Japan is well qualified to promote scientific advancement. However, the proportion of female professionals in science –including the humanities, social science, and natural science– was only 15.7 % in 2017. A 2021 OECD report– Education at a Glance 2021– estimated that in Japan, women represented only 16% of the STEM field, the lowest share among the OECD countries. The report attributed this exceptionally low rate of women's participation in Japan's STEM fields to "cultural perceptions and gender stereotypes."

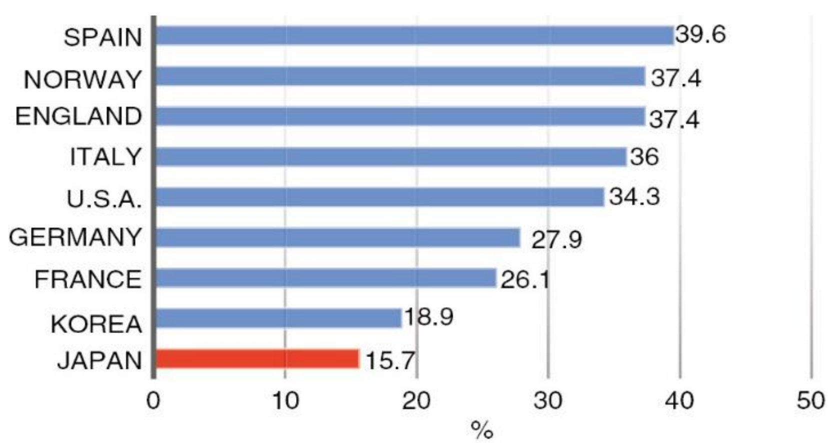

Figure 2. The proportion of female researchers in OECD countries (The Cabinet Office, Gender Equality Bureau, 2017)

In their paper, Sumida and Yumi (2023) indicated that in recent years, the number of female students choosing to pursue science education has increased in Japan. They further stated that even though the figures are increasing, according to OCED 2017, the rate is still far below the international average, and there is concern that the number of women choosing to pursue science education in Japan is low. Further, Shinohara and Fujimoto (2016) argued that women are less likely than men to persist in engineering, even after controlling other factors such as family status and work balance, and stated the need to find other factors for women's engagement in engineering in Japan. This study investigated and reported on the actual baseline perception of prospective Japanese science teachers. The following research questions were used:

1. How do Japanese prospective science teachers perceive the difference in the level of interest between male and female students when it comes to learning STEM subjects?
2. How do Japanese prospective science teachers perceive boys and girls generally perform in STEM subjects?
3. What are the understandings of the Japanese prospective teachers on advancing STEM policy in Japan?
4. What are the thoughts of the Japanese prospective science teachers on whether STEM education is attractive enough for girls in Japan?
5. Which female role model in STEM fields in Japan do the Japanese prospective science teachers know?

RESEARCH METHODS

The study employed a descriptive research survey method. According to Creswell (2014), the descriptive research method is to gather information about the present existing condition. As widely accepted, the descriptive method of research is a fact-finding study that involves adequate and accurate interpretation of findings. Descriptive research describes a certain present condition. Relatively, the method was appropriate to this study since it aimed to investigate and analyze the present perceptions of STEM facilitators about female students' participation in STEM education. The technique that was used under the descriptive method was the normative survey approach and evaluation, which was commonly used to explore opinions according to respondents that could represent a whole population. The survey was appropriate in this study because it enabled the researcher to formulate generalizations. The purpose of employing the descriptive method was to describe the nature of a condition, as it took place during the time of the study, and to explore the causes of a particular condition. The researchers opted to use this kind of research considering the desire to acquire first-hand data from the respondents to formulate rational and sound conclusions and recommendations for the study.

To be statistically significant and have a general inference on the population, it is expedient that the sample size is drawn in such a manner that is a true representation of the population size (Larry V. Hedges & Christopher Rhoads, 2009). This study adopted the simple random sampling technique to select the sample group. It was a simple random (Creswell, 2014) because each member of the population had an equal chance of being selected. After a stipulated time of gathering data, 41 respondents from various faculties namely, Education, Science, Agriculture, and Engineering all in a Japanese national university answered the questionnaire.

A direct-data survey was adopted for this study, specifically, a questionnaire. This was designed using Google forms and distributed to the prospective teachers with a link to answer online. Accordingly, the direct-data survey is used to reveal the status of some phenomenon within an identified class of people, organizations, or regions at a particular time through questionnaires and interviews to directly collect information (Brubaker & Thomas, 2000). The survey was written in Japanese language and consisted mainly of two sections: (1) respondents' profiles and (2) perceptions of female students' participation in STEM Education (see Appendix).

RESULTS

The first section of the data collected shows that 61% of the total sample were male and 39% were female prospective Japanese science teachers. Out of the total respondents, 7 respondents representing 17% were in the Faculty of Education, 22 representing 53.7% were in the Faculty of Science, 10 respondents representing 24.4% were in the Faculty of Agriculture and only 2 representing 5% were in the Faculty of Engineering. Regarding their major programs, 14 respondents majored in Chemistry, 15 majored in Biology, 7 majored in Geology and all other 4 majors namely Math, Physics, Social Studies, and Engineering had only 1 respondent. Also, 1 respondent indicated he doesn't know his major yet. Per the collected data, 39 respondents representing 95% do not have any form of teaching experience and only 2 respondents representing 5% have some teaching experience.

The second section of the results presents the views of the prospective teachers about the difference in the "level of interest" between male and female students when it comes to learning STEM subjects. Twenty-four (24) respondents presenting 59% indicated that male students showed higher interest, two (2) respondents representing 5% argued female students showed higher interest and fifteen (15) representing 36% indicated there was no difference in the level of interest between both genders.

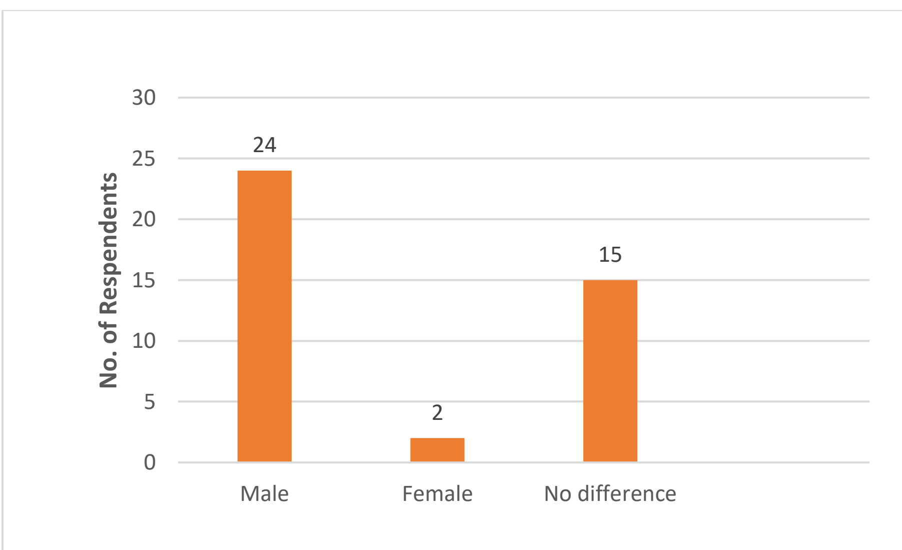

Figure 3. Gender Levels of Interest in STEM Subjects

Concerning the perception of the performance of both male and female students in STEM subjects in Figures 4 and 5 respectively. With regards to male students, 3 respondents viewed them to perform *Low*, 24 respondents thought they perform *Average*, 12 respondents thought they perform *High*, and 2 respondents thought male students perform *Very High.* As shown in figure 5, 8 respondents viewed the female students to perform *Low*, 20 respondents thought they perform *Average*, 12 respondents thought they perform *High*, and only 1 respondent thought female students perform *Very High.* None of the respondents perceived both genders to perform *Very low*. There was any significant difference in the Japanese prospective science teachers' perception of the performance between male and female students.

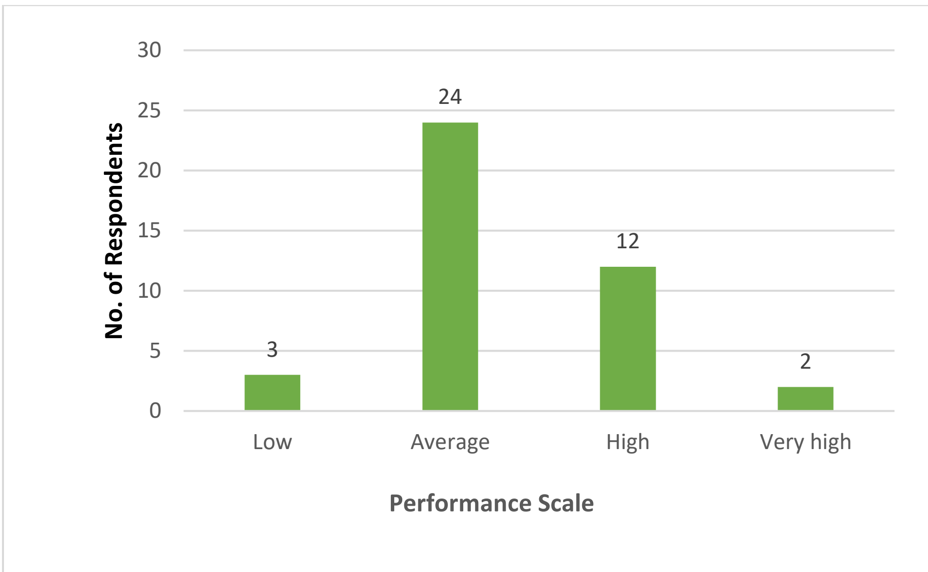

Figure 4. The perception of how male students perform in STEM subjects

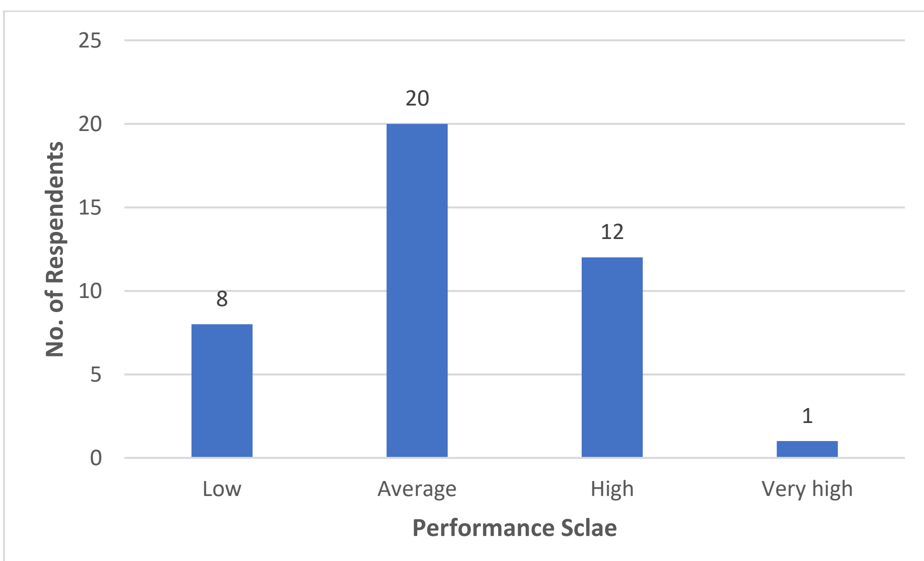

Figure 5. The perception of how female students perform in STEM subjects

On whether the prospective Japanese science teachers know a female role model in the STEM field in Japan, only 2 respondents indicated Yes. One respondent mentioned Dr. Naoko Yamazaki, an astronaut as a female role model in Japanese STEM. Another role model was Dr. Jun Tsuchiya, Associate Professor at Geodynamics Research Center, Ehime University.

In the last part of the questionnaires, the Japanese prospective science teachers commented on their thoughts on the need for the participation of girls in STEM education in Japan. To further understand their thoughts, we categorized the participants' responses based on the similarities of their ideas: STEM education at schools, involvement in the society and industry, gender-equality, STEM literacy for all, and general positive thoughts as shown in table 1.

Table 1. Japanese prospective science teachers' thoughts on the need for participation of girls in STEM education

Categories	Examples of the Responses (translated into English)
STEM Education at Schools	We need a system and teachers who understand the essence of STEM education and can pass on this concept to students. If the structure of STEM education in Japan has been established, it is good to participate. It is necessary to make sure that it does not become just another overseas trend.
	I think getting involved in high school will broaden the range of choices available to them. In fact, I had planned to go into the humanities until I was in high school. After being exposed to chemistry and biology in high school, I decided to go into the sciences. Although the number of female students going into the sciences is smaller than the number of male students, I think it has increased considerably. I think that by setting more precedents, it will be easier for female students to go into the sciences later on.
Involvement in the Society and Industry	It will make it easier for them to be more interested in and contribute to society.
	I think it will lead to the development of science fields because I think men and women have slightly different tastes and thought patterns.
	I think it's good because it will increase women's skills in STEM fields.
Gender-equality	I believe that education should be gender-neutral, so I think it is good for female students to participate.
	I think it is not good to try to make people participate regardless of gender, and I think it is good to have an environment where people can participate if they want to.
	I don't think gender matters when it comes to motivation for study and research, so I think people should learn what they want to do the way they want to do it.
STEM Literacy for All	I think it is good that everyone can learn the field of their choice, so I think they should participate.
	I think it is very good for both men and women to study science and mathematics.
General Positive thoughts	It is important.
	I think they should participate more.
	I think it should be highly recommended.

CONCLUSION

The findings of this study show that the prospective Japanese science teachers in the selected population seem to female students have a low interest in STEM Education compared to male students even though their performance is almost the same as that of male students. The results also show that most prospective science teachers have very little knowledge of STEM educational policies and other STEM-related issues in Japan. Also, very few of these prospective Japanese science teachers know female role models in the STEM fields in Japan. On the other hand, the majority argued that STEM has a positive outcome for females' participation and therefore, they should be encouraged to participate in it.

Japan as a country has many initiatives which make STEM education attractive, with the aspect of enhancing female students' participation, policymakers and education leaders need to put in more effort to make the numbers increase and make Japan become an epitome of emulation to other countries.

Acknowledgment

I am grateful to the respondents for availing themselves during data collection.

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Appendix

Questionnaire in Japanese for collecting data

1. 学年
    a. ２回生
    b. ３回生
    c. ４回生
    d. 大学院
2. 性別
    a. 男
    b. 女
    c. その他
3. 学部等
    a. 教育学部
    b. 理学部
    c. 農学部
    d. 工学部
4. 最も近い専攻分野
    a. 物理学
    b. 化学
    c. 生物学
    d. 地学
    e. 数学
    f. 工学
5. 教員経験（教育実習は含みません）
    a. ある
    b. ない

6. 質問１．STEM（科学、技術、工学、数学）の学習に関して、男女間で生徒に「興味・関心の高さ」に違いがあると感じますか？※生徒は高校生として考えてください。

    a. 男子の方が関心が高い

    b. 女子の方が関心が高い

    c. 男女間で関心の高さに違いはない

7. 質問２．STEM 分野の教科における男子生徒及び女子生徒の「成績」は一般的にどの程度だと感じますか？※生徒は高校生として考えてください。

8. 質問３．日本の STEM に関する政策についてどの程度知っていますか？

9. 質問４．日本で STEM に関する政策を進めることについて、あなたの意見を教えてください。

10. 質問５．日本における STEM 分野のロールモデルとなる女性を知っていれば、その名前と分野等を教えてください。複数名思いつく場合は、最大 10 名まで挙げてください。知らない場合は、「なし」と記入してください。

11. 質問６．日本において女子生徒が STEM 教育に参加することについて、自分の考えを書いてください。※生徒は高校生として考えてください。

12. 質問７．日本において STEM 教育は女子生徒にとって十分に魅力があると思いますか？思う、思わない、自分の考えに近い方を選び、その理由を簡単に書いてください。※生徒は高校生として考えてください。