

Women in Science and Mathematics in Japan and Asia-Oceania

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ABSTRACT

The current landscape of women's participation in STEM in Japan and the broader Asia-Oceania region still exhibits gender disparities. Despite high academic performance in STEM among Japanese students, a persistently low percentage of women pursue advanced STEM degrees, particularly PhDs in mathematics, where Japan ranks among the lowest globally. To address this gap, Japan and other countries have implemented various initiatives, such as STEM outreach programs, affirmative actions, and policy recommendations from advisory bodies like the Science Council of Japan and for mathematics in particular, associations of women mathematicians in the different continents.. Additionally, the newly established Asian and Oceanian Women in Mathematics (AOWM) organization seeks to support and promote women in mathematics through networking, mentoring, and collaborative events. The AOWM has also encouraged its members to strengthen their organizations and address/resolve the gender bias in their home countries.

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Abbreviations: AOAM, Asian and Oceanian Women in Mathematics (AOAM); AWM, Association for Women in Mathematics; EWM, European Women in Mathematics; AWMA, African Women in Mathematics Association; CGD-UMALCA, Commission for Gender and Diversity, Unión Matemática de América Latina y el Caribe; CWM, Committee for Women in Mathematics of the International Mathematical Union (IMU); ICTS, International Center of Theoretical Sciences, Bengaluru; MEXT, Japan Ministry of Education, Culture, Sports, Science and Technology; PISA, Programme for International Student Assessment; STEM, Science, Technology, Engineering, and Mathematics; RIMS, Research Institute of Mathematical Sciences, Kyoto University.

INTRODUCTION

Many countries have included the United Nations SDG#4 on gender equality as a target to attain. Data show that some countries in Southeast Asia, Central Asia, South Asia, and Oceania have attained gender parity in terms of the proportion of female researchers in their workforce.

Most Southeast Asian countries have achieved gender parity in terms of female researchers, with the share of female researchers being highest in Myanmar (75.65%), followed by the Philippines (51.2%), Thailand (49.7%), Malaysia (48.2%), Indonesia (45.8%), Brunei Darrusalam (45.2%), and Vietnam (44.8%). The countries with the lowest share of female researchers were Cambodia (23.7%) and Papua New Guinea (33.2%) (UNESCO Science Report 2021). India increased its share of female researchers from 13.9% in 2015 to 18.7% in 2018. Sri Lanka attained its gender parity of 46.6% share of female researchers in 2017. In the same year, Pakistan's share of female researchers reached 38.8%. South Korea has 20.4% women researchers. On the other hand, the percentage of female researchers in Japan rose from 14.7% in 2014 to 16.6% in 2018. Increasing this ratio has been a priority in the Basic Plans for Science and Technology of Japan since 2006 (UNESCO Science Report 2021).

This brief report will discuss the state of women in science and mathematics in Japan and professional organizations specifically in mathematics in Japan and Asia-Oceania to promote the discipline among female students and graduates and to address gender bias towards attaining equity.

Women in Science and Mathematics in Japan

Although the score in PISA, the worldwide test of math, science, and reading, for 15-year-olds in Japan is very high, few women go into STEM (Science, Technology, Engineering, and Mathematics). To address this recurring problem, many educational institutions and organizations have organized special events on STEM for female high school students for the past 20 years. Moreover, several affirmative actions to increase women in STEM were initiated for entering students in the University and in hiring faculties. However, these have not resulted in an increase in the number of women in STEM in Japan.

Gender gap in STEM

In Japan, the total number of graduates of MS and PhD in mathematics increased from 1989 to 2018 (Figure 1A) (Bannai and Sasada 2020). A slight increase in the percentage of women obtaining the Master's degree was observed but for the PhD degree, a steady decrease was noted (Figure 1B).

Figure 2 shows the % female graduates of PhD in various countries in mathematics for different years. Notably, Japan had the lowest female PhD graduates at 6% in the group for different years (Bannai and Sasada 2020). (*Korean data is female ratio in the PhD program).

Figure 3 shows PhD graduates in math and the sciences in 1998 to 2018 in Japan. Notably, in 1998, the proportion of female in mathematics was higher than in the sciences. However, after 30 years, the percentage of female graduates in the sciences increased steadily from 7.5% to 17.8% in 2018 while that in mathematics, decreased from 10.5% to 9.0% (Bannai and Sasada 2020).

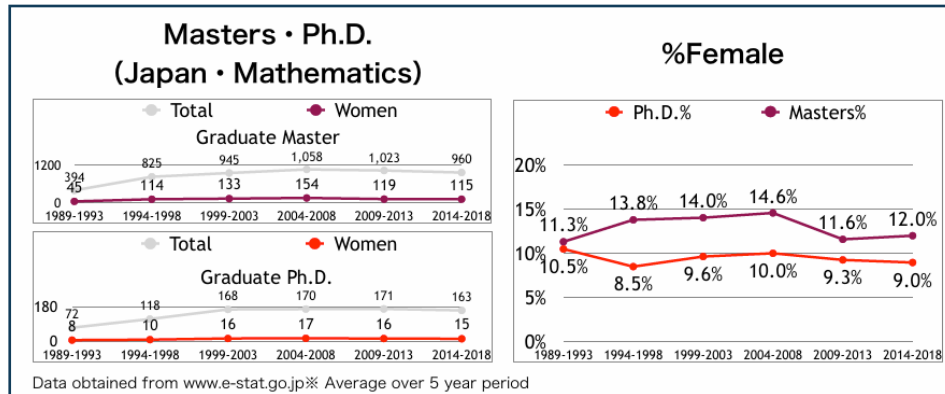


Figure 1. (a) Number of MS and PhD graduates in mathematics in Japan from 1989 to 2018. (b) Percent share of female MS and PhD graduates in mathematics in Japan from 1989 to 2018. (Bannai and Sasada 2020).

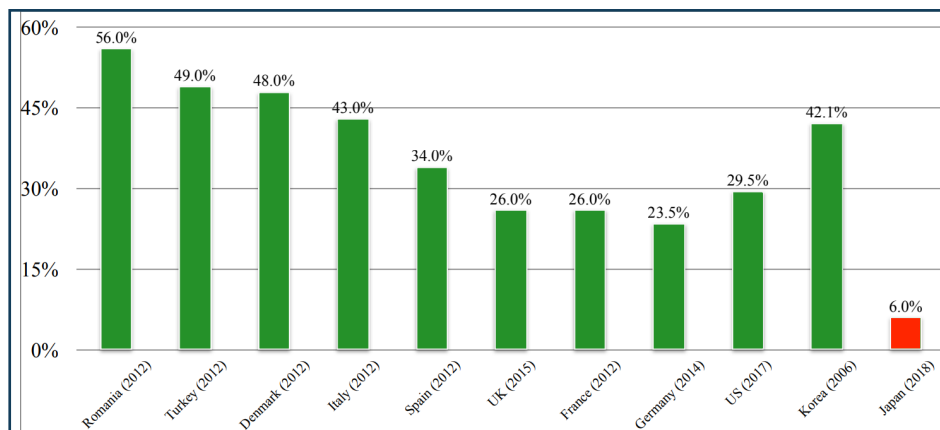


Figure 2. Female share of PhD graduates in mathematics in different countries (Bannai and Sasada 2020).

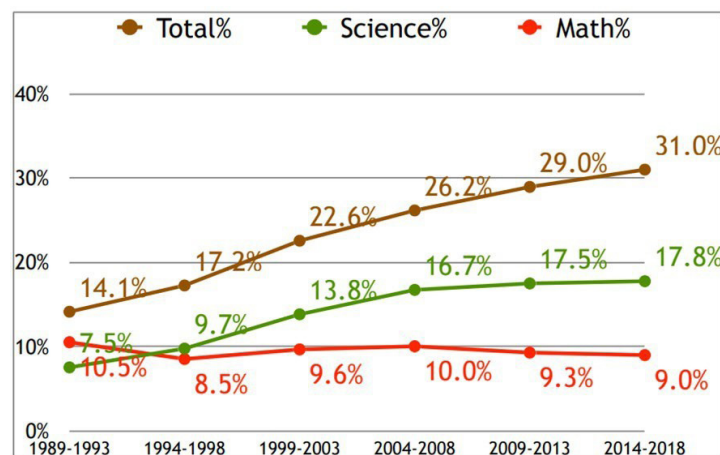


Figure 3. Comparison of female PhD graduates in the sciences and mathematics from 1989 to 2018 in Japan. (Bannai-Sasada 2020).

Science Council of Japan Gender Diversity Committee Advisory Opinion

These observations prompted the Science Council of Japan Gender Diversity Committee for Science and Technology (Section III) to study the issues. On September 22, 2023, the committee released an advisory opinion on the “importance of introducing gender perspectives into elementary and secondary education and creating a desirable environment for STEM education in order to accelerate the advancement of women into science and engineering fields” (Science Council of Japan 2023). This committee is composed of members from universities, government institutions, and private companies/organizations.

The advisory opinion noted the absence of clear national guidance to prevent gender bias in primary and secondary education. While gender equality is mentioned in social studies and home economics, this is not the case in science and mathematics education. Further, studies on the effects of gender bias are difficult to conduct due to the limited statistical data by gender in school education.

Among the recommended actions of the Science Council of Japan (2023) are the following: (a) active collection of objective data on female students’ learning environment and affective tendencies; (b) the need to include in the general provisions of the “Courses of Study” the elimination of gender bias to achieve “diversity, inclusiveness and to promote educational reform”; (c) incorporation of appropriate ways to deal with gender-related issues in training courses and recruitment of teachers by the Japan Ministry of Education, Culture, Sports, Science and Technology (MEXT); (d) attaining gender balance of teachers in charge of science, mathematics subjects and effective information and education for female students to enable them to understand that science and mathematics subjects are related to themselves. Numerical targets for the ratio of female teachers must be set by the Board of Education. Guidelines to increase and support female teachers in charge of ICT and elementary school science and mathematics subjects should be established urgently by MEXT; (e) increasing awareness of gender equality in science, mathematics, and society to raise women’s employment in technology development-oriented companies; (f) integrated efforts of various stakeholders to increase awareness among female

students, their parents and teachers that women are expected to take active roles in technical development jobs and encourage girls in elementary and junior high schools to work towards this goal.

Women Organizations in Mathematics

There are several continental organizations for women in mathematics in the world (Figure 4). The Association for Women in Mathematics (AWM) was established in 1971 with the purpose “to create a community in which women and girls can thrive in their mathematical endeavors and to promote equitable opportunity and gender-inclusivity across the mathematical sciences” (<https://awm-math.org/>). Among its programs/activities are research networks in more than 25 subject areas, mentor networks, over 100 student chapters, conferences and symposia, recognition awards, etc.

The European Women in Mathematics (EWM) was created in 1986 with the goals: “encourage women to study mathematics; support women in the careers in mathematics; shape research and university policies; connect people interested in mathematics and gender issues; promote scientific communication; and cooperate with groups and organizations with similar goals” (<https://www.europeanwomeninmaths.org/>).

The African Women in Mathematics Association (AWMA) was founded in 2013. Its aims are to promote women in mathematics in Africa and promote mathematics among young girls and women in Africa. AWMA presently has more than 300 supporters and coordinators in the five regions of Africa (<https://africanwomeninmaths.org/>).

The Committee for Women in Mathematics (CWM) of the International Mathematical Union (IMU) was created in March 2015. In September 2020, UMALCA (Unión Matemática de América Latina y el Caribe) created a Commission for Gender and Diversity (CGD). The CGD-UMALCA has been a regular collaborator of CWM, and acts as a focal point for associations for women in mathematics in Latin America. At the start of the 2019-2022 term, CWM identified the lack of a continental organization for women in mathematics in Asia and facilitated the creation of such an organization. Thus, in 2022, the Asian and Oceanian Women in Mathematics (AOAM) was established after the meeting of the Asian and Oceanian and CWM key persons.

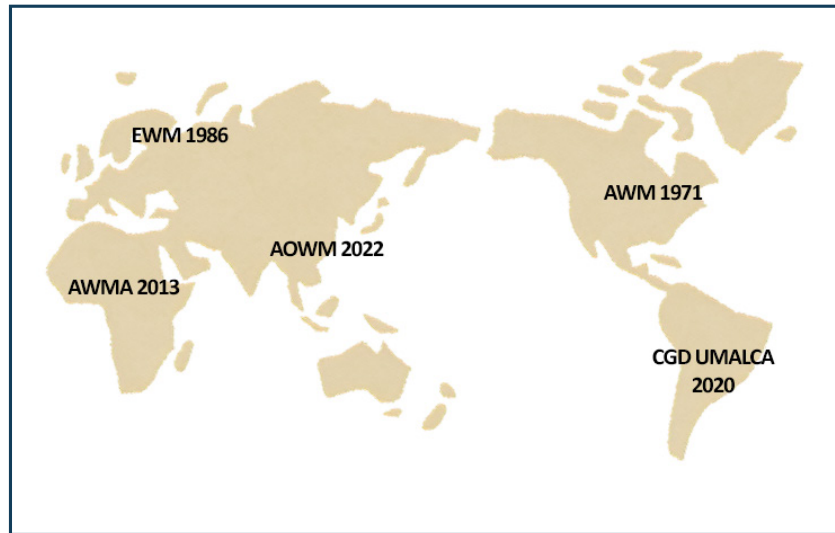


Figure 4. Continental organizations for women in mathematics. European Women in Mathematics (EWM); African Women in Mathematics Association (AWMA); Asian and Oceanian Women in Mathematics (AOAM); Association for Women in Mathematics (AWM); Commission for Gender and Diversity (CGD)- Unión Matemática de América Latina y el Caribe (UMALCA).

Asian-Oceanian Women in Mathematics (AOWM)

In this section, a new organization of women in mathematics in Asia and Oceania is introduced. The goals of AOWM are to promote activities of all aspects of women in mathematics in Asia and Oceania, and support research and career pursuit of young women, in particular. The identified activities to achieve these goals are to exchange information, strengthen communications and networks, provide meeting opportunities and places, organize forums and workshops in schools on special topics, provide training opportunities and prizes for young women in mathematics. It is also important that communication and information are easily available and exchanged through the web, mailing lists, newsletter, and data bases. The membership is open to any women working or studying in mathematics at universities in Asia or Oceania.

The history of the AOWM

In 2020, Professors Kyewon Koh Park and Soonyi Kang wrote an article on Korean Women in Mathematical Sciences (KWMS) for the AWM 50th Anniversary publication: Fifty Years of Women in Mathematics: Reminiscences, History, and Visions for the Future of AWM. Towards the end of the article, they wrote about

an association for women mathematicians in Asia. The CWM Chair Dr. Marie-Francoise Roy showed strong interest and encouraged the formation of an association in the region and helped identify the Working Group members.

The Working Group members identified were Motoko Kotani (Chair, Japan), Sanoli Gun (India), Le Thanh Nhan (Vietnam), Kyewon Koh Park (Korea), Polly Sy (Philippines), Dongmei Xiao (China), Bakhyt Alipova (Kazakhstan) and Catherine Greenhill (Australia). The working group was formed in December 2020 after which it conducted several meetings. During the second AO CWM meeting on February 25, 2022, the working group members agreed to be the founding members of the AOWM.

The AOWM Foundation Meeting was held on August 1, 2022. The total number of the first members were 216 from 17 countries (with male members). The number of members from each of these countries are as follows: Australia (7), China (6), India (54), Indonesia (1), Iran (2), Japan (34), Kazakhstan (2), Malaysia (2), Nepal (4), New Zealand (11), Pakistan (1), Philippines (12), South Korea (60), Sri Lanka (6), Thailand (9), Uzbekistan (1), Vietnam (1). Although India, Japan and South Korea have a large number of mathematicians, the female share is quite low. Thus, they need to network with other female

mathematicians outside of their countries.

The first Executive Committee members of AOWM are the following: President, Sanoli Gun (India); Vice Presidents, Melissa Tacy (New Zealand) and Polly Sy (Philippines); Secretary, Hyang-Sook Lee (Korea); and the Ordinary EC members are: Budi Nurani Ruchjana (Indonesia); Yukari Ito (Japan); Dongmei Xiao (China); Bakhyt Alipova (Kazakhstan); and Zohreh Mostaghim (Iran). (Credit: Sanoli Gun, Melissa Tacy, Polly Sy, Hyang-Sook Lee, Budi Nurani Ruchjana, Yukari Ito, Dongmei Xiao, Bakhyt Alipova, Zohreh Mostaghim) (Figure 4).

The AOWM held its inaugural meeting on April 24-28, 2023, International Center of Theoretical Sciences, Bengaluru (ICTS), Bengaluru India (Figure 5).

The AOWM: Looking forward

The AOWM plans to hold general meetings every two years. To ensure the continuity and connectivity of plans and activities, only half of the EC members will be replaced every two years.

Plans include: (a) Organizing conferences on some topics, special school for female students in mathematics to encourage and promote. (b) Exchanging program or making connections between countries. (c) Solving gender problems in each country, and so on.

The AOWM has also encouraged its members to strengthen their organizations and address/resolve the gender bias at their home country.



Figure 4. Executive committee members of the AOWM (2022). First row from left: Sanoli Gun (India); Vice Presidents, Melissa Tacy (New Zealand) and Polly Sy (Philippines); Secretary, Hyang-Sook Lee (Korea); Second row, from left to right, Budi Nurani Ruchjana (Indonesia); Yukari Ito (Japan); Dongmei Xiao (China); Bakhyt Alipova (Kazakhstan); and Zohreh Mostaghim (Iran).



Figure 5. AOWM inaugural meeting on April 24-28, 2023, International Center of Theoretical Sciences, Bengaluru (ICTS), Bengaluru India. Photo credit: ICTS

Thus, to engage the “**Women in Mathematics**” in Japan, a conference “Women in Mathematics” was held at the Research Institute of Mathematical Sciences (RIMS), Kyoto University on September 7–9, 2022 which was attended by 150 people from Japan and abroad (online). It featured several mathematical talks and reports from the AWM and EWM. The report was published as RIMS Kokyuroku No. 2248.

The following year, a conference “The World of Mathematical Sciences” was held at Kavli IPMU. August 24–25, 2023 with 135 people in attendance (in person and via zoom). An exhibit “Women in Mathematics” featured portraits of women in mathematics. The next conference for women in Mathematics and Physics is now being prepared.

Challenges and Prospects

Each country in Asia and Oceania has different problems regarding women in mathematics. Some countries have many women in mathematics but their salaries are low, and some countries have few women although with higher salaries. Thus, the AOWM has a good opportunity to learn from the older associations for various situations. Even the U.S. and Europe had few women in mathematics 30 years ago. Efforts to increase the number of mathematicians by the Association of Women in Mathematics can be studied. For one, they have a good mentoring system. Presently, the Japanese government is asking every University to have more female faculty members, but there are not enough women to fill the positions. The first step is, therefore, to start a network and encourage each other to work and succeed in academia. And a good mentoring system is very much needed. Recently, it is noted that there are some male colleagues who help the activities of AOWM. It is hoped that the current situation will change for the better in near future!

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Disclosure of conflict of or competing interest:

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