Asia-Pacific
Economic Cooperation

Advancing Free Trade
for Asia-Pacific Prosperity

APEC Cross-Border Human Capacity Building for Globalised Scientific Literacy for Future Citizenship:

Phase 2 - Longitudinal Exchange and Community Formation of STEM +Education for School Girls, Women, and Teacher Professional Development

APEC Human Resources Development Working Group

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For
Asia-Pacific Economic Cooperation Secretariat
35 Heng Mui Keng Terrace
Singapore 119616
Tel: (65) 68919 600
Fax: (65) 68919 690
Email: info@apec.org
Website: www.apec.org

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Introduction

There is an increasing demand for considerable numbers of new employees competent in scientific literacy in APEC regions to facilitate economic development and growth. However, the number of individuals with STEM educational background is decreasing, leading to workforce shortage in STEM fields. Furthermore, women's development in economies has been prioritized in 2019 by the host economy, Chile, and then accentuated at the 37th APEC HRDWG Education Network Meeting in Malaysia. Considering this, this project aims to continue the focus on STEM-Plus education from the previous project and put the emphasis on gender issues to promote capacity building and inclusive growth among APEC economies. The Phase 2 project focuses on promoting female participation in STEM-Plus education, and a two-day webinar was arranged to provide an opportunity for participants from different economies to exchange knowledge and information about STEM-Plus education and relevant gender issues. At the webinar, 6 keynote speakers were invited to deliver speeches on their research concerning STEM-Plus education and gender issues, 8 delegates from different economies were nominated to give presentations on current states and strategies to promote women and girls in STEM-Plus fields, and 4 panelists attended to share their ideas about promoting women and girls in STEM-Plus education.

Current State of STEM-Plus Education and Relevant Gender Issues in APEC economies

Pre-event Survey

Prior to the webinar, a survey was conducted to understand the current state of STEM-Plus education and relevant gender issues in APEC economies. 16 delegates from 8 economies responded, with 13 females and 3 males.

According to the Figure 1, three-fourths of respondents claimed that the concept of STEM-Plus had been incorporated in formal education, and the Figure 2 shows that three-fourths of delegates indicated that the idea of STEM-Plus had been introduced to the standard curriculum for students before their entry into universities in their economies, but it is noticeable that in several economies, students gain the idea of STEM-Plus when they are in the third or fourth grade or in high schools. None of the responses from the economies indicated that their curriculum standards started to introduce STEM related topics during grades five and eight. The figures illustrate that STEM-Plus education is not only important in many economies but also substantially implemented and promoted in different economies.

Is STEM-Plus currently incorporated in the standard curriculum of formal education in your economy?

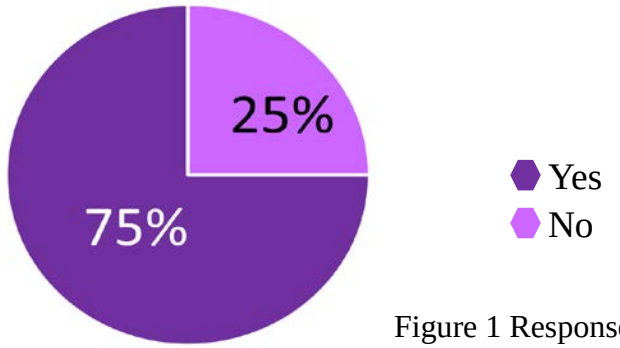

Figure 1 Responses from APEC delegates

How early is the concept of STEM-Plus introduced in the standard curriculum?

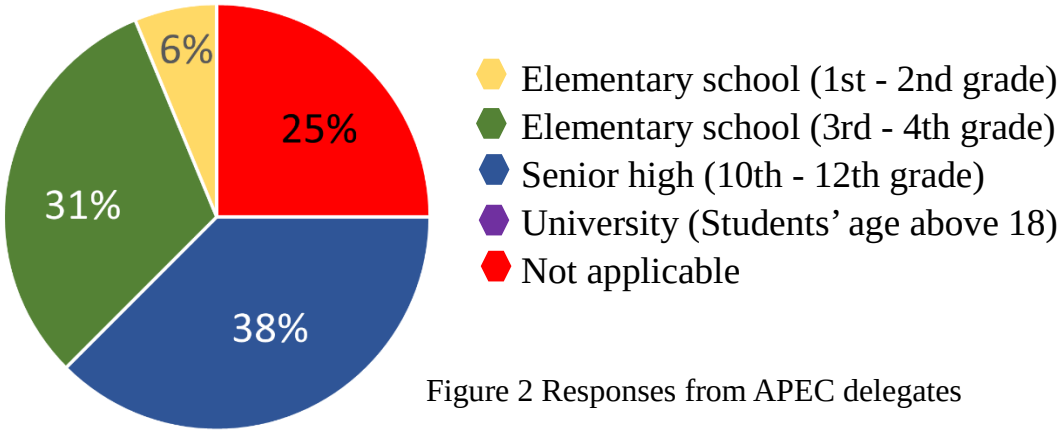

Figure 2 Responses from APEC delegates

In addition, the survey shows that gender issues in STEM-Plus education have been targeted by most of economies with many challenges faced with females in STEM fields proposed. For instance, respondents from five economies namely Peru, Philippines, Russia, Singapore and Viet Nam, thought that compared to boys, girls are less likely to choose STEM subjects in higher education or pursue STEM careers. Other than that, many economies proposed that the lack of qualified educators with STEM educational background, the imbalance in resources and funding, and stereotypes of gender roles may directly or indirectly influence females' development in STEM-Plus education.

In response to these challenges, 8 delegates gave presentations to describe gender issues in STEM-Plus education in their economies respectively and proposed ongoing strategies to address the problems.

Delegates' Presentations

Chile

It was emphasized that Chile's per capita GDP could increase by 20% if there was gender parity in the labor market, and there was a phenomenon that although female enrollment in higher education is proportioned to male enrollment, females are less likely to choose majors related to science and engineering.

In the light of the situation, several strategies were practiced to close gender gap in Chile. Some engineering schools of Chilean universities have developed programs to attract more female students. For example, Special Admission Systems for Women was developed to guarantee special quotas for female applicants to engineering programs. There was also a voice calling to incorporate the gender equity variable in quality criteria for the accreditation of higher education institutions in Chile.

Malaysia

The Malaysian government has recognized the need to promote female participation to facilitate economic and domestic development. Therefore, over 50 years, Malaysia has made efforts to develop policies to make education more accessible to girls. In 1960s, most girls didn't enroll in schools, but in 2012, education was almost free for all Malaysian children. In addition, to encourage girls in STEM-Plus education, the residential science schools were built to provide quality STEM education. The supportive policy Malaysian Women Policy was launched to empower women to be knowledgeable, creative and innovative, and at the same time demonstrate good moral values.

So far, the Malaysian government has made a considerable achievement in promoting gender equality and inclusiveness in STEM fields and will continue to support females and the development of STEM-Plus education, benefiting not only Malaysia but the rest of the world.

Mexico

There were four student projects completed in Mexico, including Mexican Materials Society Chapter UDG, Student Energy at UdG, The IEEE Cut Student Branch and The Developer Student Clubs of the Cut DSC. In each project, students formed teams to attend scientific activities and conferences.

While working on projects, students proved themselves doing well and teachers were more like guides and tutors. Furthermore, female participation was already

30% in STEM areas and giving us vision that more and more females would be involved in STEM areas.

Peru

In Peru, there are three departments dedicated to promoting females in scientific and technological areas.

In the Department of Regular Basic Education, the curricular proposal for basic education and STEM put emphasis on gender equality, and according to the data provided by the Department of Teacher Evaluation, the number of female teachers and male teachers who were promoted in the public teaching career was the same. Moreover, the Domestic Competition for Best Teaching Practices was supported by the Department of Teacher Recognition, in which many recognized proposals were in STEM areas.

The Ministry of Education in Peru also made efforts to encourage females in STEM-Plus education. The Domestic Observatory of best practices and educational innovations was established to serve as a platform to promote professional learning community and provided proposals by others for browsers to get inspirations.

The Philippines

The Science Education Institute of the Department of Science and Technology plays an important role in promoting STEM-Plus education in Philippines. It is in charge of administering students' scholarships and providing teacher trainings.

According to the figures, although it is evident that in the past 5 years, male STEM scholarship grantees were more than females in higher education in general, more females were willing to attend teacher training programs such as Specialized STEM Training and Project STAR (Science Teacher Academy for the Regions) Trainings than males.

With information provided, it's clear that much more things need to be done to contribute to a better gender balance in STEM fields in Philippines.

Russia

In Russia, females were challenged by several factors while pursuing STEM-related disciplines in education or STEM careers. For example, the male-centered job enrollment requirement and male dominance in leadership and management positions caused females' tendency to underestimate their abilities and strengths. The stereotype of gender role also made it difficult for females to maintain work-life balance. To cope with the problems, the initiative of The Domestic Action Strategy for Women for 2017-2022 was proposed in Russia to encourage women to serve as representatives in

industries and to improve incomes for women in the hope of making women audible on governmental levels.

USA

In the United States, it has been proved that female students outperformed male students in NAEP Technology &Engineering Literacy Assessment, but degrees awarded to women in higher education are imbalanced in STEM-related disciplines. The factors contributing to STEM gender gap include gender stereotypes, male-dominated cultures, and fewer role models in STEM fields.

Many federal agencies made efforts to address the issues by launching programs such as INSPIRE Women Act by NASA and Clean Energy Education and Empowerment Women's Initiative by Energy. Also, a couple of research-based suggestions were provided to encourage girls in STEM-Plus education such as telling girls academic abilities are improvable, exposing girls to female role models succeeding in math and science, and providing spatial skills training.

Viet Nam

There were mainly two projects implemented to encourage girls and women in STEM-Plus education in Viet Nam. The first project Promoting School Girls' Interest and Participation in Science and Innovation through STEM Education and Digital Skills implemented in 2018 was to encourage girls to choose STEM subjects in higher education and then pursue STEM careers by arranging workshops and conferences for them. The second project Built-It included the leadership forum for the Women in STEM Leadership Program and organized many activities to arouse females' interest in STEM fields.

To minimize the gender gap in STEM fields, there were a couple of suggestions provided by Viet Nam. Firstly, it's important to develop more policies on women and girls, and training programs are necessary for educational managers and teachers. Secondly, organize STEM competition for girls and women to inspire their potential. Finally, create programs to engage girls in STEM from an early age.

The presentations given by delegates from different economies gave us clear insights into implementation of STEM-Plus education for girls and women in each economy. The keynote speeches delivered by 6 keynote speakers and the panel also expanded our vision on gender issues in STEM-Plus education.

More Insights into Women and Girls in STEM-Plus Education

Keynote Speeches

The first keynote speaker, Professor Jung Sun Kim, quoted data from the USA to demonstrate the existence of gender equality paradox. The data showed that female students with STEM educational background tend to pursue careers irrelevant to STEM fields after graduation, and their good performance on the test seems not to change their mind. Furthermore, there is a phenomenon that as the society become more gender equal, women are less likely to obtain STEM degrees. According to the APNN Collaborative Study spanning from 2014 to 2018, the situation was caused by different perceptions from women and man. For example, gender barriers in laboratories were more perceived by women; compared to women, men were more optimistic than females toward future careers of women in STEM. To address the issue, Professor Kim proposed several suggestions to overcome the gender barriers. It's very crucial for women to join networks that can set gender norms in STEM, and women's voice need to be heard and supported in the future. Last but not the least, people ought to be aware that gender barriers do exist, but in different way from the past.

Professor Judy Anderson, the second speaker, focused on STEM education for girls in Australia. In Australia, it's evident that female students are less confident and less interested in STEM subjects and are underrepresented in STEM fields, and perhaps the problem is associated with their declining participation in senior school subjects, poor attitudes and engagement in mathematics, and low aspiration toward STEM careers. Therefore, the change in curriculum, emphasized by Professor Anderson, is necessary to solve the problem. Accordingly, a program STEM Teacher Enrichment Academy was conducted to get teachers to design curriculum suitable for students. In this program, teachers were required not only to improve their literacy but also co-design integrated curriculum, aiming to promote STEM aspirations and more positive STEM attitude. Although there was variability in changes of curriculum and not every curriculum was very successful, the impact of STEM curriculum on girls was confirmed in many aspects.

The third speaker, professor I-Jy Chang, argued whether guaranteed quota for female students in STEM education worked. She supported her argument by showing figures illustrating the practice of guaranteed quota in two situations, selection for International Olympiad and science class for gifted students in Chinese Taipei. Although the figure showed that the practice in the selection for International Olympiad was not much encouraging, guaranteed quota seemed to promote female students' performance in science class for gifted students. They improved and ranked higher than their original rank after entering the class. In conclusion, guaranteed quota encouraged those who need confidence, and the accompanied intense environment enhanced the performance of

female students. Female students are capable but less confident in STEM subjects, so they need more encouragement in the future.

Professor Merrilyn Goos, the fourth speaker, drew on two projects to identify factors explaining gender gap in STEM disciplines and to identify effective interventions in addressing gender gap. From the first project, a framework of factors influencing female participation, achievement and progression in STEM studies was displayed, explaining that the gender gap may be caused by individual learners, family and peers, schools, and society. To address the issues, interventions such as providing career counselling and information, encouraging and supporting parental engagement, and developing positive school culture are necessary. In addition, three good initiatives implemented by Netherland, United Kingdom, and EU to promote females in STEM were extracted from the database and illustrated by Professor Goos. Finally, it was emphasized that no single type of intervention is always effective in achieving gender equity in STEM education. Therefore, evaluation of interventions is indispensable and the alignment matters.

Then, Professor Joseph Krajcik indicated that how to build learning environments that allow students to develop motivation to learn science and scientific practices and competencies is a challenge, and the key solution is to design, develop and test a system, which includes specified teacher and student materials, professional learning supports and formative assessment, for advancing science teaching and learning. Therefore, two five-year projects, Crafting Engaging Learning Environments (CELE) and Multiple Literacy in Project-based Learning (ML-PBL) were implemented and the result was quite positive, which proved the system did work for all genders, races and ethnicities, and increased students' academic achievement.

Finally, Professor Tang Wee TEO, the last speaker, used three cases to illustrate varied dilemmas females were faced with in STEM fields. Their confusion may be caused by intersectionality of gender and race, hegemonic school structures, and intersectionality of gender and age. To cope with the problem, it is necessary to understand origins and evolution of stigma and stereotype, and then identify constructive solutions to remove barriers. Moreover, the importance of positionality was emphasized since it could be a good tool for reflective and reflexive curriculum, and males' opinions ought to be included to stimulate diverse perspectives.

Panel: Supporting Women and Girls in STEM-Plus

Professor Silvina Ponce Dawson began her presentation with focus on the gender perspective in STEM education. She first clarified the idea of the gender perspective, which focuses on gender-based differences in status and power and considers how such discrimination shapes the need and interests of women and men, and

emphasized the importance of introducing it into STEM since they are among disciplines where gender gap exists. Also, a couple of aspects revealing the gender gap were proposed such as glass ceiling, persistence of stereotypes and invisibility and gender violence. To reduce the gender gap, cultural changes and the direct involvement of the community are necessary. The cultural change could be promoted through policies of government and institutions. For example, the Argentinian Ministry for Science, Technology and Innovation launched a Program for Gender Equality in 2020. As for the direct involvement of the community, two initiatives, the NSF ADVANCE Program by the USA and Project Juno by the institute of Physics in the UK, were in progress. Furthermore, Professor Dawson also shared several activities organized to promote women in STEM with the gender perspective.

Professor Sheau-Wen Lin, the second panelist, explored and compared pre-service female elementary teachers' beliefs of and attitude toward STEM education in four different economies: Chinese Taipei, Thailand, Korea and Japan. Though the results showed that teachers' attitude and beliefs vary among economies, they were suggested to prepare themselves by cultivating interests in STEM issues, actively learning new technology and skills, and enhancing curriculum design and problem solving abilities to face new challenges in education.

Then Professor Mariko Ogawa drew our attention to the gender gap in STEM-fields in Japanese academia. In Japan, females are still under-representative in STEM fields. For example, in Tohoku University, the ratio of female faculty members and doctoral students is not proportioned to that of male faculty and doctoral students. To encourage more girls to choose STEM subjects, Science Angels Programme was implemented to nurture the next generation, and the programme included seminars, forum with senior female researchers and role models for girls. Furthermore, many gender equity programmes in Tohoku University are still ongoing to nurture more female leaders in STEM fields.

The panel was closed by Professor Chia-Li Wu. She introduced a number of international and regional networks such as International Network of Women Engineers and Scientists (INWES) and Korea Women Scientists and Engineers (KWSE) that promote females in STEM and encouraged women to form the networking to keep supporting females in STEM fields.

Post-event Survey

After the webinar, the post-event survey was conducted to evaluate the success of the webinar. 11 delegates from 7 economies made responses and most of them are positive.

According to the Figure 3 and 4, over 80% of delegates strongly agreed that the webinar was well-organized and easy to follow, providing a great deal of useful information concerning females in STEM-Plus fields.

Furthermore, many delegates indicated that keynote speeches and delegates' presentations were informative, insightful and speakers were professional. Also, the responses revealed that both keynote speeches and delegates' presentations provided practical strategies and innovations that apply to different economies, which achieved the goal of capacity building for women and girls.

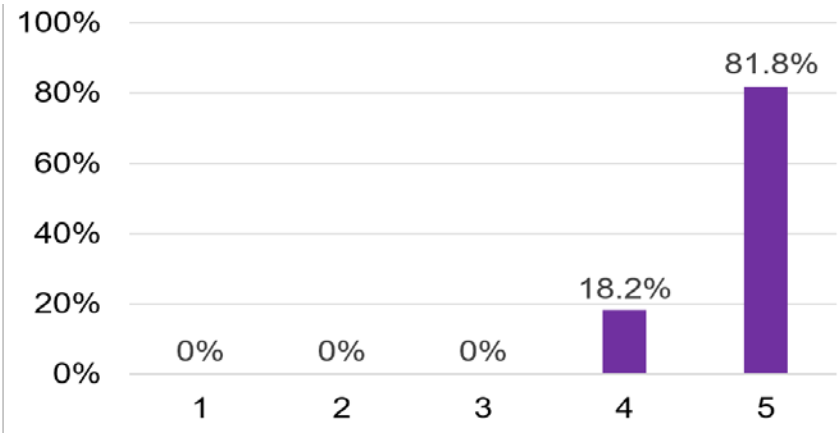

Figure 3 The percentages of responses to the item of "The webinar was well-organized and easy to follow."

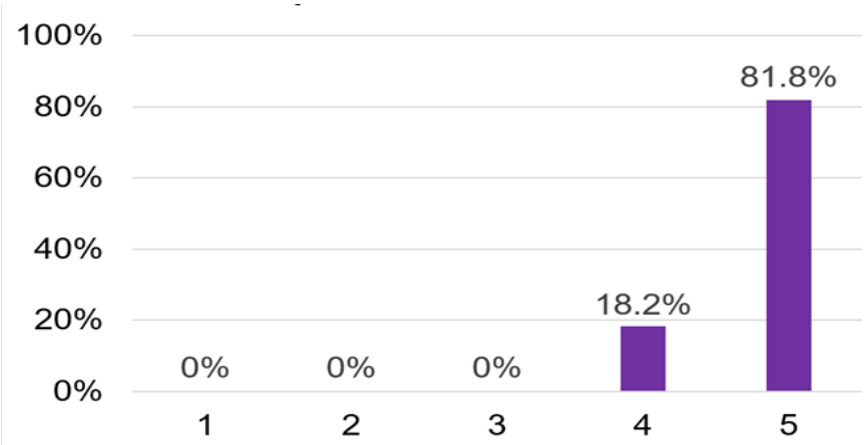

Figure 4 The percentages of responses to the item of "The speeches and presentations delivered were relevant to the topic of the webinar."

In general, most delegates agreed that the webinar had met their expectations and helped them understand practices on gender issues in STEM-Plus education, but they also pointed out that more interaction and discussion among participants are necessary for the improvement of the webinar.

Conclusion

The goal of the project is to provide a platform for experts and participants to exchange ideas and information regarding gender issues in STEM-Plus education, and then the capacity building among participants will lead to the long-term impact on each economy, promoting female participation in STEM-related fields and facilitating economic growth. After evaluating the effectiveness and impact of the webinar, it is evident that the goal of the project has been achieved after the 2-day webinar. According to responses from the delegates, a majority of them recognized that the webinar was informative and substantial, not only providing a great deal of information regarding STEM-Plus education and gender issues for them to ponder but included diverse perspectives from different economies, which led to inclusive growth among economies. In short, the webinar was confirmed to be successful and the community of STEM-Plus education was formed for future collaboration and development among APEC economies.