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Importance of Networking and Role Models for Women in Science, Technology, Engineering and Math

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Abstract: In Japan, the number of female researchers in Science, Technology, Engineering and Math (STEM) field is quite low. Scant attention has been paid to the causes of female researcher's underrepresentation. On the other hand, considerable improvement in gender equality policy has been made in Norway. In this study, female researchers in STEM field in Tokyo Institute of Technology (Tokyo Tech) and Norwegian University of Science and Technology (NTNU) were investigated by using a questionnaire and hearing survey. The questionnaire survey revealed two important issues to be improved in Tokyo Tech; "the difficulty to balance work & family" and "the lack of the opportunities to find role models". In NTNU, the combination of multidisciplinary mentoring and networking had a great success, suggesting that it is important and effective for females to "meet" outstanding females and "know" the experience of them. "To meet people and see the world" will support females and they can gain confidence in their future.

Key words: gender equality; STEM; female researcher; role model; networking
JEL codes: Z0

1. Introduction

According to the Global Gender Gap Index, Japan was ranked 101st among 145 countries in 2015. The percentage of female researchers in Japan is 14.7% in 2015, and is the lowest rank among comparison countries. The percentage of the female to doctoral students in Japan is increasing in recent years, however it is still less than 30%, and is lower than principal countries in the world (Figure 1). The percentage of female researchers in Japan has increased in all the fields, however the rate of science and engineering field is still low (Figure 2). Tokyo Institute of Technology also faces the shortage of female researchers. However, this issue is not well recognized. Especially, there are limited opportunities for female students to contact with "role models" in Tokyo Tech. It is important to support female researchers for balancing their work with child care more, and to support female students for choosing science courses in their life. However, it is difficult for Japanese society to acknowledge the importance of putting emphasis on the gender equality policy.

On the other hand, in Norway, almost all universities have a high percentage of female researchers and Norwegian University of Science and Technology (NTNU) is a typical example that is much promoting gender equality. In their opinion, although 50% of students are female, NTNU is still far from the goal of gender balance

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in senior academic positions. The proportion of female professors has more than doubled from 8.5% in 2000 to 23.1% in 2014 but it is still low in Norway.

In order to investigate the reason why the number of females is quite low in Tokyo Tech, and to figure out the solution to encourage and support females, questionnaire and hearing survey were conducted in both Tokyo Tech and NTNU. Furthermore, the influence of a student project to encourage females was examined.

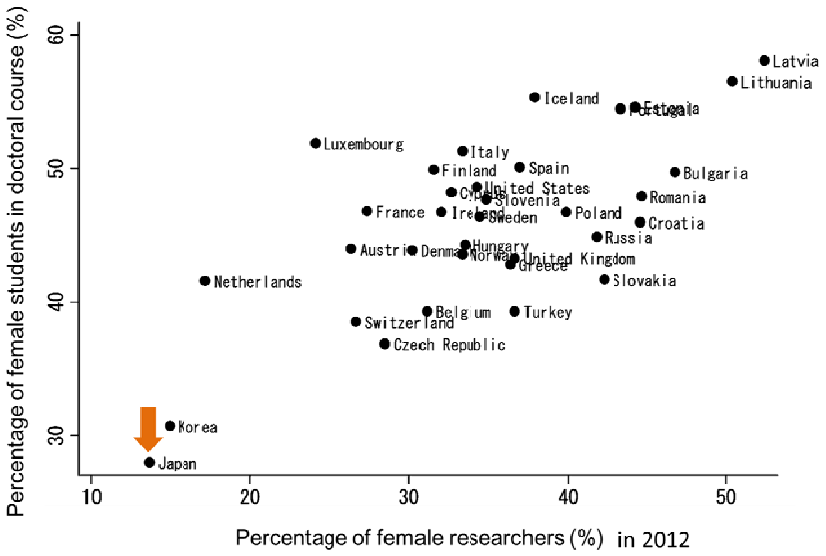
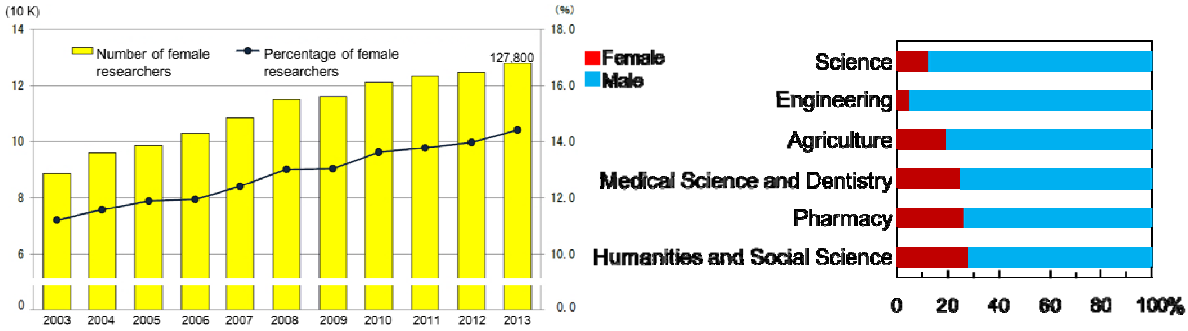


Figure 1 Percentage of Female Researchers and Female Students in a Doctoral Course in Each Country (2012)



(a) **(b)**

Figure 2 (a) Changes in the Number and Percentage of Female Researchers in Japan, (b) Percentage of Female Researchers in Each Field in Japan (2012)

2. Methods

Hearing survey was conducted to one female assistant professor and one female professor in the department of Metallurgy and Ceramics Science in Tokyo Tech. Based on the survey, the model to support female researchers in Tokyo Tech was designed. According to the model, questionnaire survey was carried out to clarify the problems female researchers are facing at Tokyo Tech and NTNU. The questionnaire objective females answered on papers in Tokyo Tech and through the internet in NTNU. Finally, the feedback to Tokyo Tech was presented based on the obtained results by questionnaire survey. Current status of each university is shown in Figure 3.

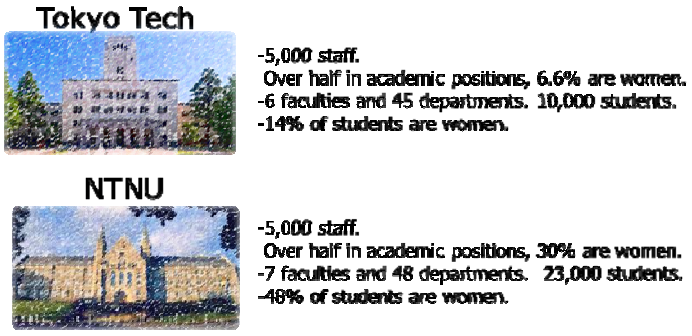


Figure 3 Current Status of Tokyo Tech [3] and NTNU

3. Results

Based on the hearing survey for female faculties at Tokyo Tech, the support model for female researchers in Tokyo Tech was designed as shown in Figure 4. Eight issues and expected solutions related to gender equality were arranged. Based on the model, comparison between Tokyo Tech and NTNU through questionnaire survey was conducted.

3.1 Females in Tokyo Tech

3.1.1 Gender Issues and Activities in Tokyo Tech

Tokyo Tech is the top national university for science and technology in Japan with a history spanning more than 130 years. In 2008, Gender Equality Center (GEC) was established to pursue the gender equality policy at Tokyo Tech. GEC supports male and female faculties, staffs, and students in Tokyo Tech to show their full potential in an environment of mutual respect. Actions are implemented based on Tokyo Tech's Policy on Gender Equality as follows:

(1) Formulating and implementing policies relating to the promotion of gender equality

(2) Carrying out surveys and analysis of the current state of gender equality

(3) Education and dissemination of information relating to gender equality

(4) Providing advice and consultation services on issues relating to gender equality

(5) Other activities relating to gender equality

Basically, activities for promoting gender equality consists of "A Shift in Consciousness", "Environment and Equipment Services", "Securing Equal Opportunities" and "Training Young Talent" in Tokyo Tech. To create an environment both males and females can all fully develop their talents and personalities, GEC uses all opportunity to build and cultivate awareness of gender equality issues. GEC also provides a flexible system, user-friendly advice services in order to improve the work-life balance. In order to help faculty and students balance their work or studies with their role in their home, Tokyo Tech covers a portion of the babysitting fees for faculty or students currently bringing up children. In addition, GEC put high importance on providing equal opportunities for both sexes in terms of employment, promotion, and participation in the decision-making process. Job information e-mail service for female researcher is available. GEC works actively to increase the academic and institutional strength of the university by means of energetic and diverse human resources.

However, there is no mentoring service specialized for females in Tokyo Tech. Moreover, there is no lecture or class regarding gender equality study. Because of the small number of females, it is sometimes hard to clarify and define what females really want the university to provide them in Tokyo Tech. It is also difficult to find a

proper female who can make a lecture and to gather the people to the lecture. Figure 5 shows the sex ratio of faculties and students in Tokyo Tech. Terribly small number of females is in Tokyo Tech. In such environment, it is sometimes difficult to make a connection among females.

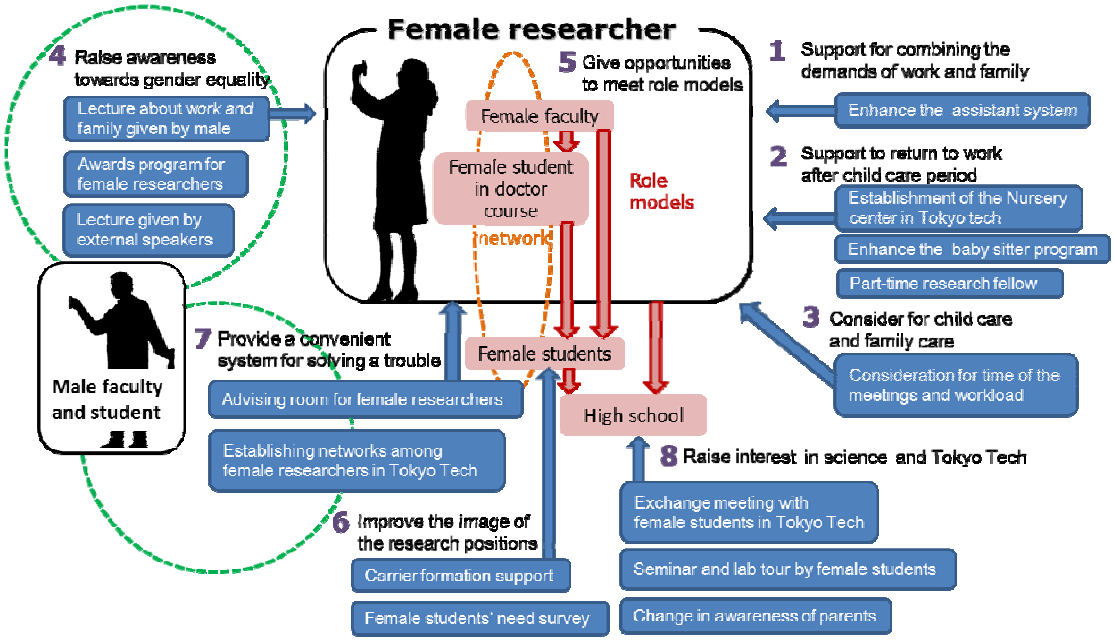


Figure 4 Support Model for Female Researchers in Tokyo Tech

3.1.2 Questionnaire Survey in Tokyo Tech

Questionnaire was asked to all departments in Tokyo Tech and 36 females responded. The position and age group of them is shown in Figure 6. 44% of them are married and 33% have children. The total number of children is 18.

Based on the questionnaire results, “difficulty of balancing family and job” and “lack of opportunity to meet role models” is the most important issues in Tokyo Tech (Figure 7). Child care support has been greatly progressed by GEC, however there are still some problems. For example, in Tokyo Tech, we couldn’t get financial support for business travel with the child. The financial burden concerning child care has to be reduced to support female researchers. Also, child care and assistance system are well established, but it’s not well known. To increase awareness of the system is needed (Figure 8). In addition, the importance of role models needs to be concerned.

For female professors themselves, they might feel that they don’t need a role model to pursue their work life balance. For female students, it’s really competent to “know” the path females researchers walked. Once female students know the path, they became confident and challenge to something new. The opportunity to meet role models is really limited in Tokyo Tech. Main events in Tokyo Tech are followed:

(1) Tea party for female alumni and students twice a year

(2) Student project for study tour to some companies and for events to meet role models

(3) University COOP event for new female students in every April

(4) Special lecture and lab tour for high school girl students

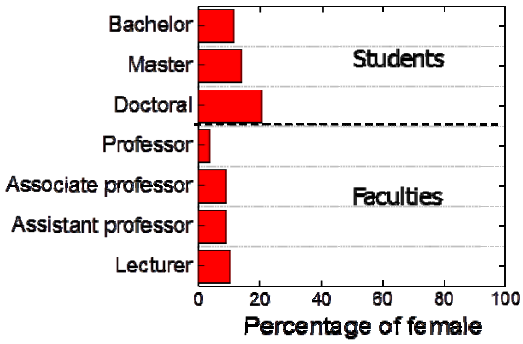


Figure 5 Sex Ratio of Faculties and Students in Tokyo Tech (2014)

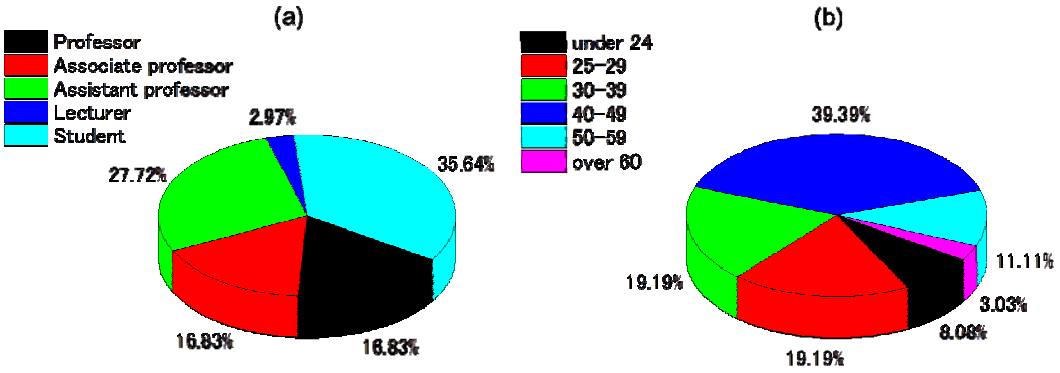


Figure 6 (a) Position and (b) Age Group for the Questionnaire Respondents in Tokyo Tech

The student project is now popular in Tokyo Tech. Students in the project member gather female students and alumni to share their experiences. Furthermore, the students visit companies where female alumni work at and interview them. The interview article will be put on the student project's website to spread it. The student project has been achieved to give opportunities for female students to meet role models and to enrich the network among females in Tokyo Tech. It should be promoted more to solve the problem concerning lack of opportunity to meet role models (Figure 8).

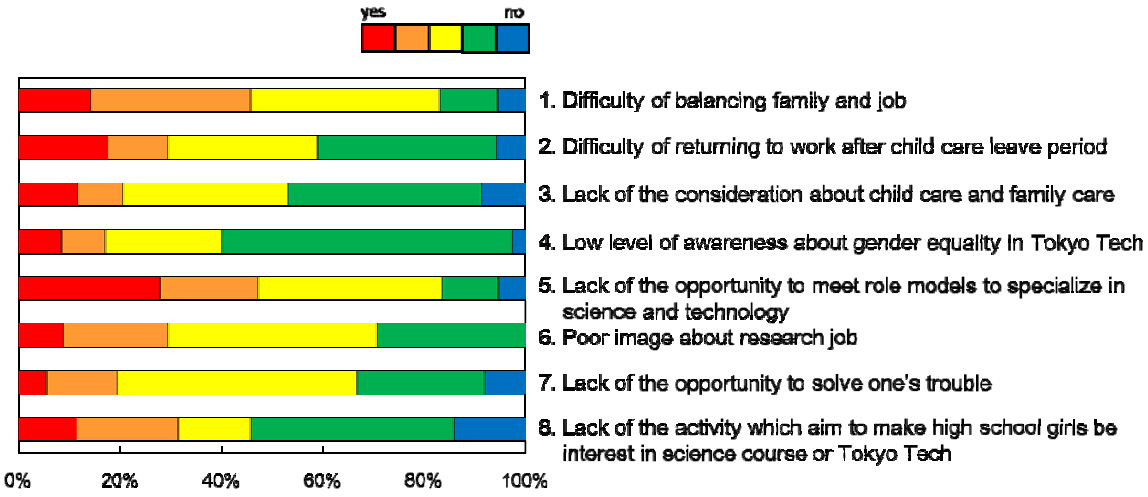


Figure 7 Obtained Answers For a Question "Are Those Issues Important to Be Improved?"

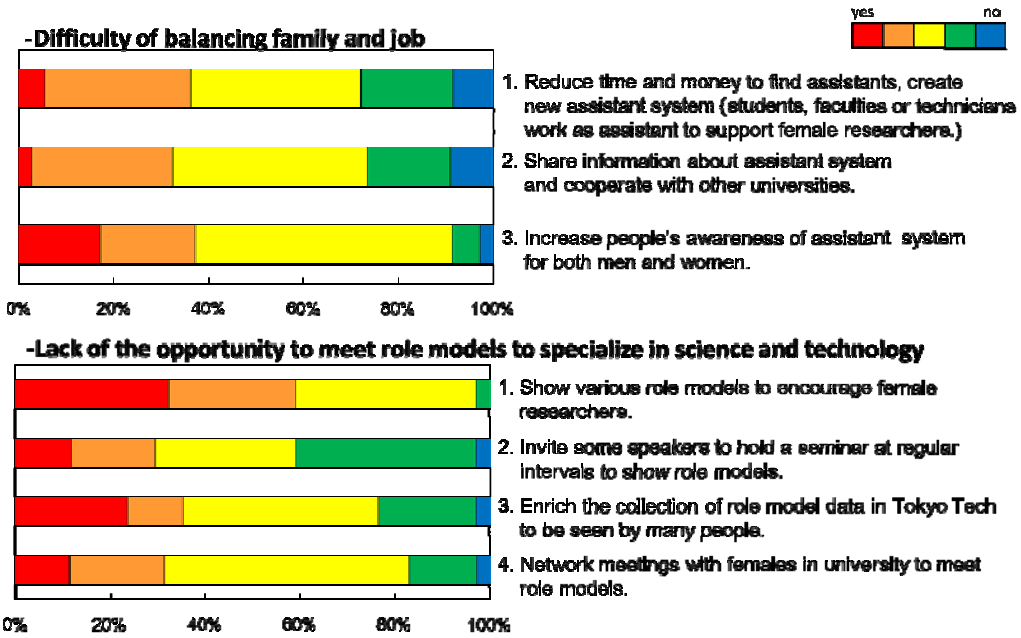


Figure 8 Expected Activities to Solute the Problems Regarding Difficulty of Balancing Family and Job and Lack of Opportunity to Meet Role Models in Tokyo Tech and Percentage of Females Who Want to Promote Those Activities

3.2 Females in NTNU

3.2.1 Gender Issues and Activities in NTNU

In Norway, almost all universities have a high percentage of female researchers (Figure 9). NTNU is one of them, and gender equality policy has been highly promoted. In 2014, 36.4% researchers at full professor position were female (Figure 10). In addition, 50% of the students are women. 37% of the students in science and technology are female and 18% of the students in ICT (Information and Communication Technology) are female (Figure 11). NTNU gave an action plan for a better gender balance for 2014-2016 in January 2014. It was written by the Rector. In the central measures, there are mentoring program and networking building for females with PhD candidate, post doctor and associate professor positions. Also NTNU has “start-up packages” for women in permanent scientific positions in subject areas where the proportion of women was under 25% — Areas such as mathematics, the natural sciences and technology. A start-up package comprises money for equipment, running costs and for paying wages. Women in general do not negotiate as good research conditions as men. The start-up packages are attempting to remedy this. Newly appointed female associate professors and full professors can obtain 300,000 NOK. As a newly appointed member of the staff it needs time to generate a sufficient volume of research activity in relation to financing, so this program really encourages females.

An experienced person with great integrity and influence in the research community (the mentor) acts as a supervisor and discussion partner for someone who wants to develop her career (the mentee). The program aims to promote an exchange of learning and experience, as well as to help both parties build their networks and expertise. For female researchers, it’s nice to have someone else to talk to except for their supervisor in the lab. They can receive support and the support gives strength. Also there are mutual benefits to mentees and mentors. In this program, mentors are professors, both men and women. Mentees are women in PhD candidate, postdoc and associate professor positions. The goals of the mentoring programs in NTNU are followed:

(1) Organize a dialog meeting among mentors for exchanging of challenges and ideas about the academic culture;

(2) Make visible and increase the knowledge about the qualification of our female researchers;

(3) Organize networking for female researchers.

According to the experiences of mentee about dialog with mentor, it is very important to have a mentor from the other department to be able to discuss difficulties in their own department. Mentor gave mentee access to hidden knowledge in academia. Also, the dialog between them often continues after closing the mentor program. Network meeting is highly appreciated by mentees. The combination of multidisciplinary mentoring and networking is a huge success in NTNU.

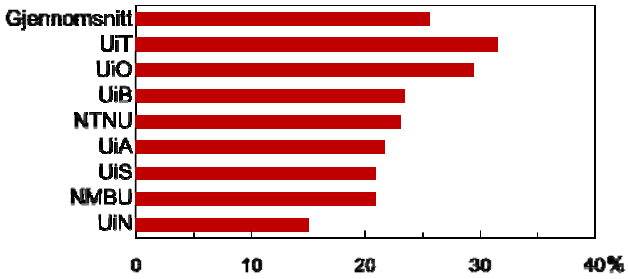


Figure 9 Percentage of Female Professors at Norwegian Universities (2014)

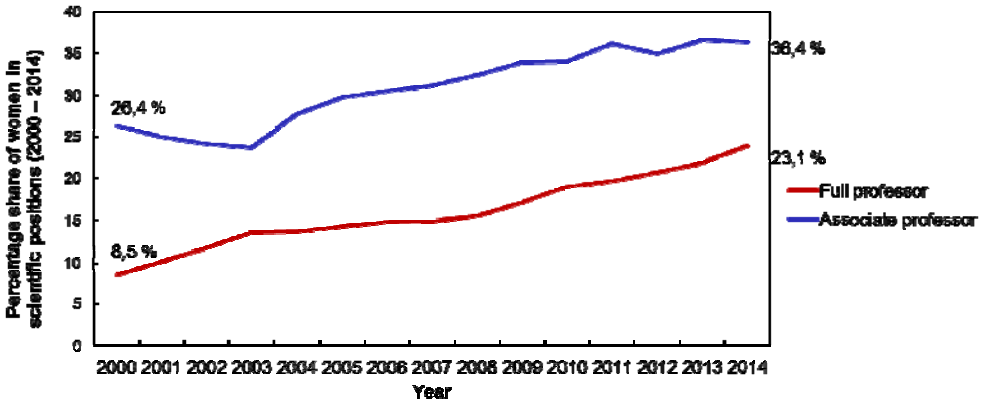


Figure 10 Changes of the Percentage of Female Professors and Associate Professors in NTNU

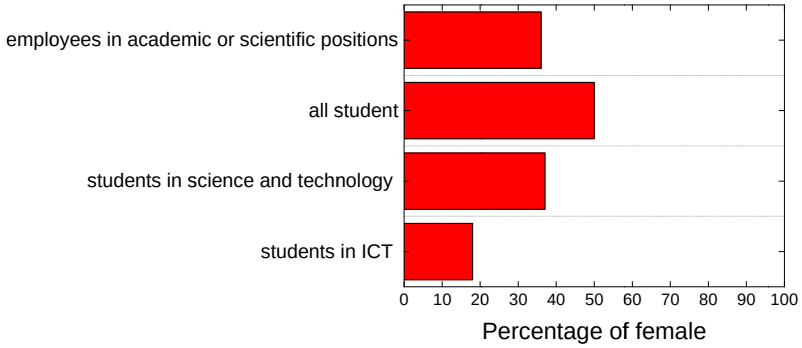


Figure 11 Percentage of Females in NTNU

3.2.2 Questionnaire Survey in NTNU

Questionnaire was asked to all departments in NTNU and 38 females responded. The position and age group

of them is shown in Figure 12. Comparing the result of Tokyo Tech, so many students are interested in the survey replied to it. 68% of females corresponded to the survey are married and the total number of children is 60 (Figure 13). It suggests that it is not rare for NTNU students to marry and have children during their PhD, and the support of the university might be substantial.

Based on the questionnaire results, “lack of activity which aims to make high school girls be interested in science course” has the greatest attention from females in NTNU (Figure 14). Expected activities to solute the problem in NTNU are followed:

(1) Network meetings with all females in university (no obligation to be present at.)

(2) Lectures given by female researchers to show role models and support students in career choice.

(3) Inspiration meetings for 2nd and 3rd year students to intensify the recruitment of master’s students to PhD positions

(4) Technology-camp at NTNU for high school girl students

Inspiration meeting is remarkable activity and should be promoted more (Figure 15). In NTNU, two annual recruitment events only for girls are held. One is Technology-camp and only covers ICT, the other is girls’ day and covers all science and technology studies at NTNU. Girls studying applied mathematics a high school are encourage to apply. NTNU pick the best qualified, and also make sure they have a nationwide distribution, and not too many from the same school. What they want is for the girls to experience personal meetings with female professors, female directors in the IT sector and female students studying technology, which serves as role models. Those events have succeeded in breaking stereotypes is able to be expanded.

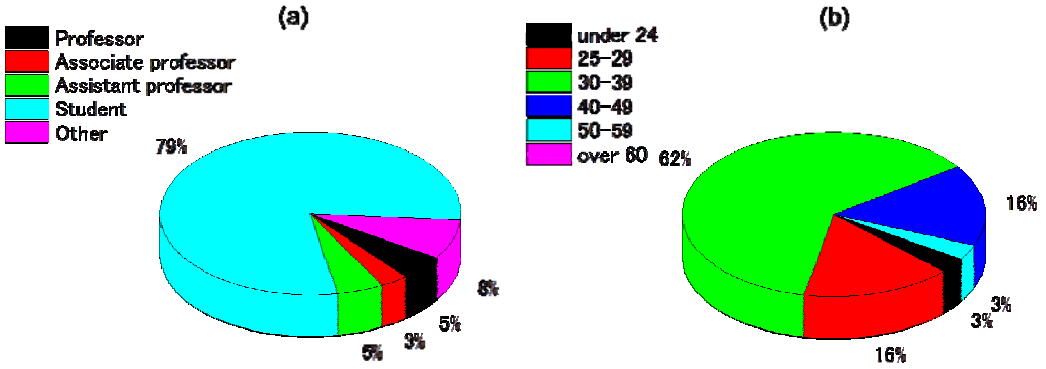


Figure 12 (a) Position and (b) Age Group for the Questionnaire Respondents in NTNU

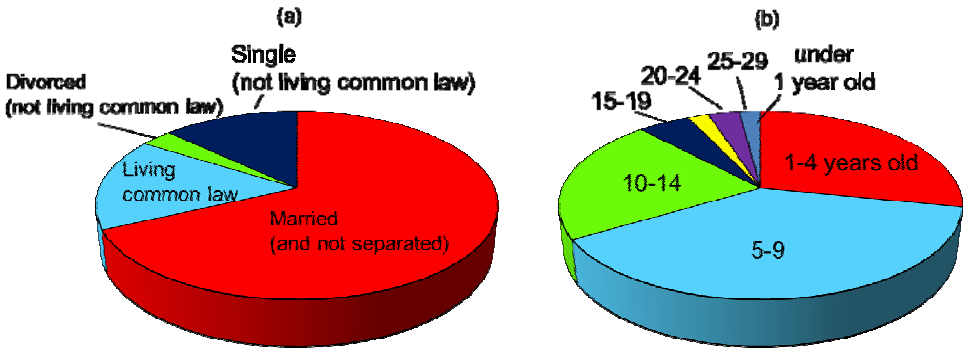


Figure 13 (a) Marital Status and (b) Number of Children of Females Corresponded to the Survey in NTNU

The most remarkable thing is that 74% of females corresponded to the survey proud of NTNU gender equality policy. Furthermore, most of them don't know about the mentoring program which is highly established and promoted in NTNU. Females who had used the mentor program could achieve to share experiences, build their self-confidence, and build network outside their own department. Detail contents of those females are listed in Table 1. Most females are well connected with the other PhD candidates and employees in their department and they provide the role of mentor. Almost all female students corresponded to the survey have suitable supervisors for their PhD and they provide the role of mentor. They have a large network of both friends and colleagues with whom they talk to and discuss with, and ask for advice so that they can feel this network give sufficient support to them. However, the main problem is the "lack of interest" of women in science. That is how women have been raised in the preceding decades. There are activities for boys and activities for girls, and girls should not go away exploring, shouldn't get dirty, should dress nicely and behave. That encouraging science and technology in school, especially for girls, should raise the participation of women in science. Change in the folk beliefs about the appropriate role of a woman in society is most important.

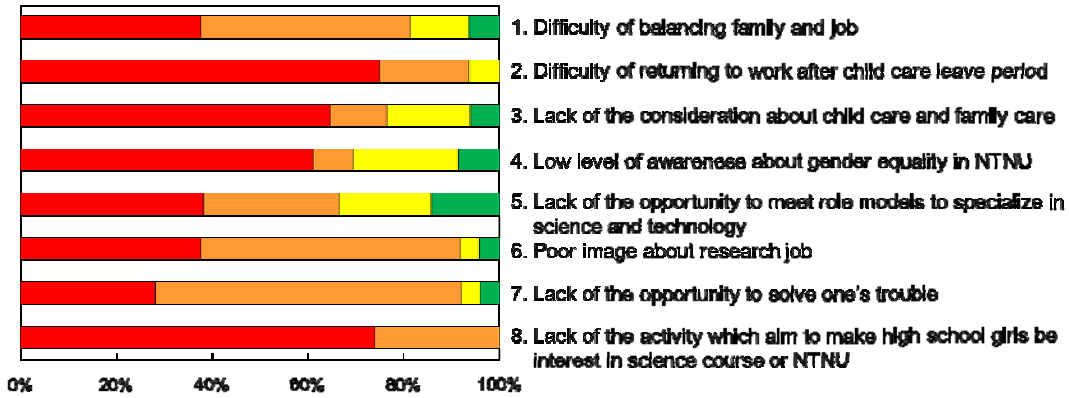


Figure 14 "Are Those Issues Important to Be Improved?" Eight Issues Related to Gender Equality and Questionnaire Results in NTNU

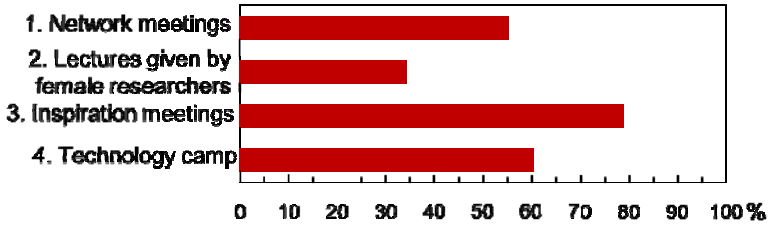


Figure 15 Expected Activities to Solute the Problem in NTNU and Percentage of Females Who Want to Promote Those Activities

Table 1 Examples of Mentoring Result in NTNU

Example	Mentor	Comment from mentee
1	Male professor from other department	A significant benefit in addition to the personal reward was the awareness of equality issues the participation brought. Several woman from my department have participated and we have managed both to alter processes and challenge the mentality in the department regarding equality issues afterwards.
2	Female engineering from same department	It feels safe to have someone to sit next to during lunch until you get to know more people and you get a lot of social information that is important to know.
3	Male professor from other department	Not necessary for the mentor but for the other meeting with the candidates. It's good to share some experiences and again sort out what could be dealt with on another level and what should be deal with on more personal level.

4. Feedback to Tokyo Tech

Through the survey, it was found that there is insufficient opportunity to share the experience among females in Tokyo Tech comparing to NTNU. To meet role models can be helpful for not only female students but also female faculties to resolve problems regarding work-life balance. Here, influence of the student project regarding gender equality on female students in Tokyo Tech is investigated. Current activity of a student project is shown in Table 2. The grade and department of female students who attended the study tour to a company where female alumni work at are summarized in Figure 16 (a), (b) respectively.

The study tour gave female students great opportunity to meet role models and create a vision of their future (Figure 17). The tour also helped them to create a network among female students. Furthermore, since it is sometimes hard for female students to decide whether to go to the doctoral course, it was great opportunity to talk with a female who has experienced it. In addition, female students realized that there are no difference in labor conditions among men and women. Networking activity and opportunity to meet role models are beneficial for females to create vertical and horizontal relationships among females.

Table 2 Current Activities of the Student Project in 2015

2015	April	May	August	September	December
Activity	Welcome party	Study tour to the Ministry of Agriculture, Forestry and Fisheries	Student forum in Tokyo Tech	Study tour-2 the Japan Aerospace Exploration Agency	Networking activity in Tokyo Tech

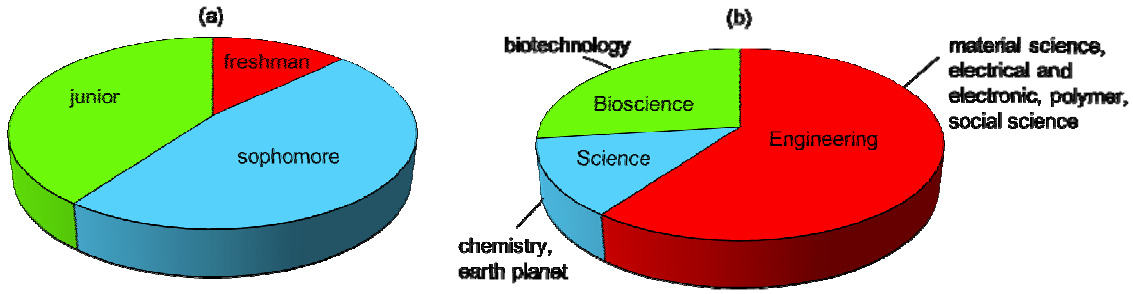


Figure 16 (a) The Grade and (b) Department of Female Students Who Attended the Study Tour in September 2015

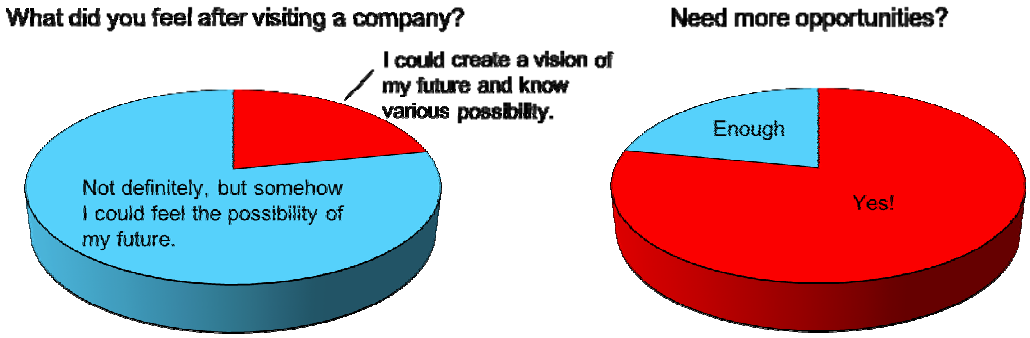


Figure 17 Review of Female Students Who Attends the Study Tour in September 2015

5. Conclusion

Comparison between Tokyo Tech and NTNU successfully clarified importance of networking activity and opportunity to meet role models. It is due to the constant effort for gender equality policy that females in NTNU satisfy with their environment and follow their interest. The number of female researchers has been increasing in

Tokyo Tech, however we should not have let go the gender equality issues. One must constantly be aware, think long-term, keep saying and attract the interest of people.

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