Section 2 Improvement of Environments for Increasing Opportunities for Diverse Human Resources to Play Active Roles

As described in Chapter 1, a wide variety of human resources need to play active roles in order for diverse problems to be solved based on science and technology. As the dwindling birth rate has resulted in a reduction of Japan's working-age population, it is necessary to enlist people whose potential has not been fully utilized due to various constraints.

Section 2 first summarizes the current trends regarding diverse researchers by focusing on young, female and international researchers, and it identifies issues that need to be addressed for increasing opportunities for these researchers to pursue research more actively. Then, some of the efforts that are being made are shown, and future directions are suggested.

1 Improvement of Environments toward Helping Female Researchers to Become More Active

These days, we see and hear more about world-leading female researchers. The 2013 Nobel Prize in Physics was awarded jointly to François Englert and Peter W. Higgs for their theoretical work on the Higgs boson, which has contributed to our understanding of how subatomic particles exhibit mass. The ATLAS group at CERN (the European Organization for Nuclear Research), which greatly helped to bring the Nobel Prize to these two physicists by discovering the Higgs particle, was represented by the female researcher Fabiola Gianotti.

Female Japanese researchers have also been achieving world-renowned results. In March 2014, Kayo Inaba, a professor at the Kyoto University Graduate School of Biostudies and vice-president of the at university, was honored as a recipient of the L'Oréal-Unesco Women in Science Award, which supports eminent women scientists who have made important contributions to the life sciences. The award was founded in 1998 to recognize leading women scientists, and it is given in the life sciences and the physical sciences in alternating years. Laureates are selected by independent international juries that include Nobel Prize winners. Laureates from Japan include Professor Emeritus Tsuneko Okazaki (Nagoya University, 2000), Professor Emeritus Fumiko Yonezawa (Keio University, 2005), Professor Emeritus Akiko Kobayashi (University of Tokyo, 2009) and Professor Reiko Kuroda (the Research Institute for Science & Technology at the Tokyo University of Science, and professor emeritus at the University of Tokyo, 2013).

Ceremony for L'Oréal-Unesco Awards for Women in Science
Courtesy of Nihon L'Oréal K.K.

Active participation by female researchers has had many positive effects on their co-workers and students. MEXT conducted a questionnaire survey[1] on the views of colleagues of female researchers, and female students studying under female researchers. Responses to the survey include the following views:

- Female researchers who manage to work while raising children serve as role models for other researchers, because they are required to use their time efficiently, and thus, they are highly organized in advancing research.
- Seeing female researchers continue to work while bearing and raising children encourages young female researchers and students.
- Female researchers help others who have difficulty in balancing career and family life, by providing advice and useful information.
- Female researchers are superior in taking care of details; thus they are scrupulous and sensitive in research and teaching.

Although leading female researchers have been achieving great results, women account for a smaller share of researchers in Japan than in other major countries, as indicated in Chapter 1. Female researchers are said to positively affect those around them. Growth in the number of female researchers is desirable also for the purpose of raising academic standards and advancing research in Japan.

The current situation regarding female researchers and students in Japan is first summarized below. Next, issues that need to be addressed for ensuring more opportunities for these researchers to perform research more actively are identified. Then, some of the efforts that are being made are described, and future directions are suggested.

(1) Current situation regarding female researchers, and issues that need to be addressed

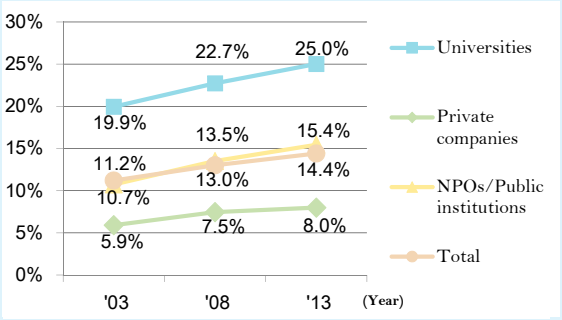
Section 2 of Chapter 1 showed that women account for a smaller share of researchers in Japan than in other major countries, although female researchers, share of all researchers has been increasing year by year. The current situation of Japanese female researchers is reviewed in detail below.

1) Affiliations of female researchers

Although the share of female researchers has been increasing at all types of organizations, that share remains at 25.0% at universities, 8.0% at private companies, and 15.4% at public research institutions, as of 2013. The share of female researchers at private companies (8.0%) is particularly small (Figure 1-2-17).

Regarding male researchers, about 60% work at private companies and 30% at universities. In contrast, 60% of female researchers work at universities and 30% at private companies (Figure 1-2-18). The *Survey on Research Activities at Private*

Figure 1-2-17 / Changes in the Share of Female Researchers, Broken Down by Affiliation

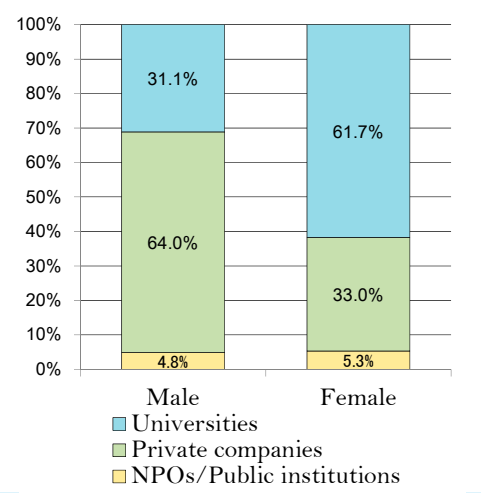


Source: MEXT based on the *Survey of Research and Development*, MIC

1 This questionnaire survey was conducted by MEXT from February through March 2014 at universities supported by the MEXT program *Supporting Activities for Female Researchers* funded by the Special Coordination Funds for Promoting Science and Technology. Nine universities responded to the survey. *Supporting Activities for Female Researchers* is a MEXT program for supporting excellent projects at universities and public research institutions that serve as models for developing environments which are favorable for female researchers to perform at their full potential. In these projects, efforts are made to improve research environments and to make changes in ways of thinking held by people concerned with helping female researchers to balance careers and motherhood and to fulfill their potential in pursuing research. This program was implemented by MEXT from FY2006 to FY2011. From FY2011, this program was integrated into the *Program to Support Research Activities of Female Researchers*.

Corporations 2012 published by NISTEP in September 2013 shows that of the 448 private companies that employed scientists specializing in R&D in FY2011, only 219 employed female scientists. As these data indicate, female researchers at private companies as a share of all female researchers is lower than male researchers at private companies as a share of all male researchers; there are not many companies that employ female scientists.

Figure 1-2-18 / Affiliations of Male/Female Researchers: Share



Source: MEXT based on Survey of Research and Development, MIC

One cause for this situation regarding female researchers seems to be a mismatch between supply and demand in the employment of researchers. According to the *Survey on Research Activities at Private Corporations 2012*, the companies that need relatively large numbers of researchers specializing in science and engineering are automobile and auto parts manufacturers, information and communications machinery/equipment manufacturers, and commercial machinery/equipment manufacturers. These three types of manufacturers respectively employ 949, 844 and 328 researchers per year on average. As will be described in detail later, the mismatch between supply and demand in the employment of researchers is partly a result of the fact that fewer female students than male students major in science or engineering.

The Japan Association of Corporate Executives published the policy proposal *Toward Creation of Diversity on Decision-making Boards* in November 2013. In this proposal, the current situation regarding electrical machinery and equipment manufacturers is described by a manufacturer who said "Electrical and mechanical engineers are in high demand within the company, but it is difficult to immediately increase the number of female engineers in career-track positions because the number of female students majoring in electrical, electronic or mechanical engineering is very limited." As these words indicate, the undersupply of female scientists makes it hard for private companies to employ female engineers even when they are willing to do so.

Some private companies have laid out policies for promoting active roles for women. The Japan Business Federation announced the *Action Plan on Women's Active Participation in the Workforce: Enhancing Corporate Competitiveness and Achieving Sustainable Economic Growth* in April 2014. This action plan states that top-level executives and all employees should fully understand and accept that women's active participation in the workforce is a path toward enhancing corporate value by boosting competitiveness, and thus it is a strategy for ensuring the sustainable growth of Japan's economy and society. According to the action plan, private companies specifically need to formulate and announce corporate voluntary action plans, enhance career consciousness and support career paths.

Some companies, however, have not yet developed support systems or changed their career consciousness to promote women's active participation. The Japan Association of Technology Executives published *Recommendations on Positive Actions Toward Women's Active Participation in the Workplace* in April

2013. According to the results of a questionnaire survey shown in this document, the biggest disincentive for female engineers to play more active roles is the current male-oriented corporate culture; other disincentives include the lack of career plans for women and the absence of communities or networks of female engineers.

While some private companies have been making voluntary efforts by publicizing mid- and long-term positive actions in their business plans, there are companies that have not made progress in changing their career consciousness. It is hoped that people at private companies and other members of society will work together to accelerate efforts for promoting women's active participation in the workplace.

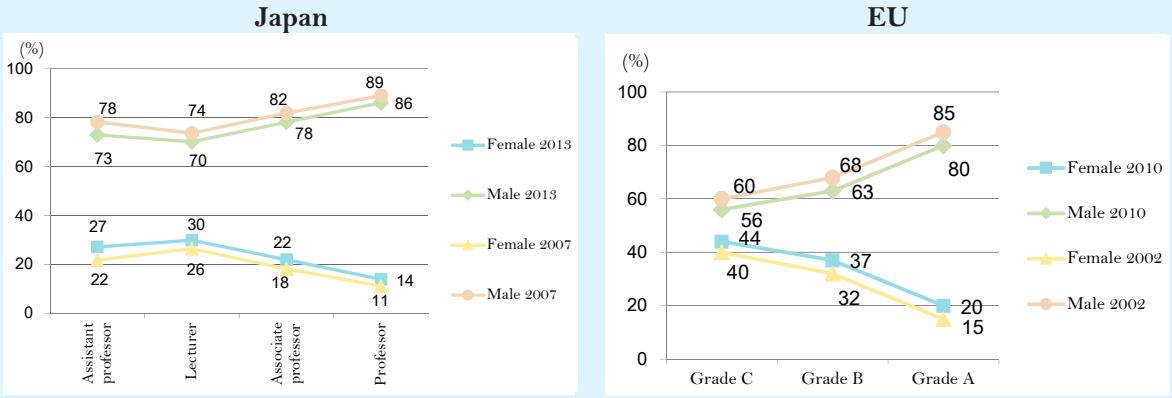
2) Current situation regarding female researchers at universities

About 60% of women researchers work at universities. Because this share is high, the current situation regarding women researchers is outlined below, with a focus on universities.

(i) Academic career paths for female researchers

Not many female researchers hold leadership positions at universities in Japan, and female researchers account for a smaller share of positions at the higher levels. European countries have similar trends, and the situation has been slightly improving in both Japan and Europe (Figure 1-2-19).

Figure 1-2-19 / Shares of Male and Female Faculty Members: Japan and the EU



Note: "Grade A" corresponds to professors. "Grade B" corresponds to associate professors and lecturers. "Grade C" correspond to assistant professors.

Source: MEXT based on *Fiscal 2008 School Basic Survey* and *Fiscal 2013 School Basic Survey* for Japan and on *She Figures 2012* (European Commission) for the EU.

The U.K. is alarmed at its situation in which female researchers hold only a small share of senior academic positions. On February 6, 2014, the House of Commons Science and Technology Committee published a report on the careers of female scientists titled *Women in Scientific Careers*[1]. In this report, the committee stated: "Although women make up 44.5% of academic staff across higher education institutions in the UK, only 20.5% of professors are women. Women are under-represented at professorial levels across academic research careers in all STEM[2] disciplines, typically 17%. It is astonishing that despite multiple initiatives to improve diversity in STEM, women still remain under-represented at senior levels."

1 House of Commons Science and Technology Committee, *Women in Scientific Careers* (http://www.publications. parliament.uk/pa/cm201314/cmselect/cmsctech/701/701.pdf)

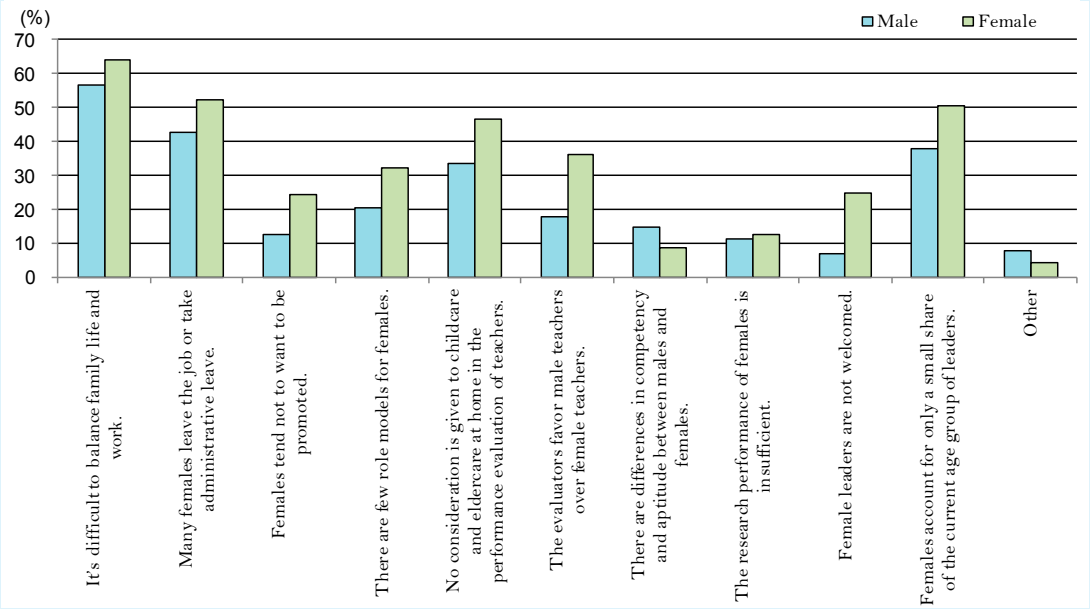
2 STEM: Science, Technology, Engineering, and Mathematics

According to the *Fiscal 2013 School Basic Survey*, women account for 8.4% of university presidents and 7.1% of university vice-presidents in Japan. The five Japanese universities ranked in the top 100 in the *Times Higher Education World University Rankings 2013-2014*-- The University of Tokyo, Kyoto University, Tokyo Institute of Technology, Osaka University and Tohoku University--have never had a female president.

The American College President 2012 released by the American Council on Education in 2012 shows women to account for 26% of college presidents in the USA, a significantly higher percentage than in Japan. Among the world's top universities in the USA, Harvard University has a woman president, and Massachusetts Institute of Technology has also had one. Thus, female scholars are far less represented at senior levels in universities in Japan than in the USA.

The results of *the 3rd Large-scale Survey of Actual Conditions of Gender Equality in Scientific and Technological Professions* (hereinafter: *"the 3rd Survey"*) published by the Japan Inter-Society Liaison Association Committee for Promoting Equal Participation of Men and Women in Science and Engineering in August 2013 gives some reasons why not many female Japanese researchers hold leadership positions. The reasons include "difficulty in reconciling work and family life", "a high turnover rate and frequent absences from work", "a small share of women in the generations holding leading positions" and "no consideration given in performance evaluations to the situation of female researchers burdened with caring for children or family members" (Figure 1-2-20).

Figure 1-2-20 / Why Not Many Female Researchers Hold Leadership Positions



Source: *The 3rd Large-scale Survey of Actual Conditions of Gender Equality in Scientific and Technological Professions*, Japan Inter-Society Liaison Association Committee for Promoting Equal Participation of Men and Women in Science and Engineering (EPMEWSE), August 2013

With not many female senior researchers holding leadership positions, younger women wishing to take leadership roles in research in the future find it difficult to plan their careers. When young female researchers face difficulties in balancing work and family life and in making career plans for taking senior

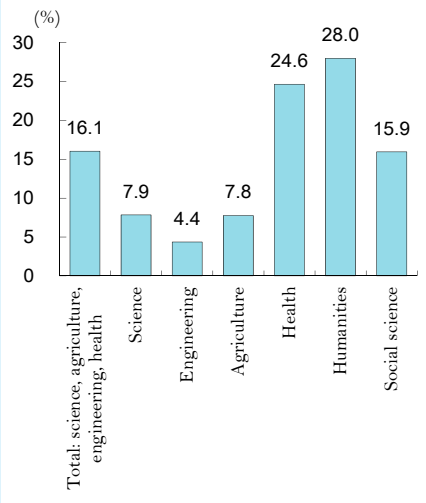
positions, they deepen their anxiety about their future, unless senior female researchers in leadership positions are available to give them emotional support. Consequently, these young female researchers may leave their jobs when they become greatly burdened with child care. In other words, the number of female researchers aspiring to leadership positions has not been increasing because only a limited number of senior female researchers already hold such positions.

(ii) Female faculty members by academic discipline

Women account for 7.9%, 4.4% and 7.8% of the faculty members in science, engineering and agriculture, respectively. The share of female faculty members in engineering (4.4%) is particularly small (Figure 1-2-21).

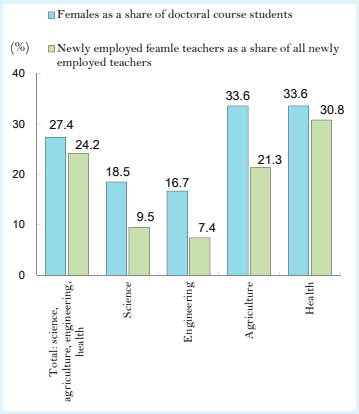
Women as a share of newly employed faculty members is more than 9 percentage points less than women as a share of doctoral students in science, engineering and agriculture (Figure 1-2-22).

Figure 1-2-21 / Women as a Share of All Faculty Members, Broken Down by Academic Discipline



Source: MEXT based on the *Fiscal 2010 School Teachers Survey*

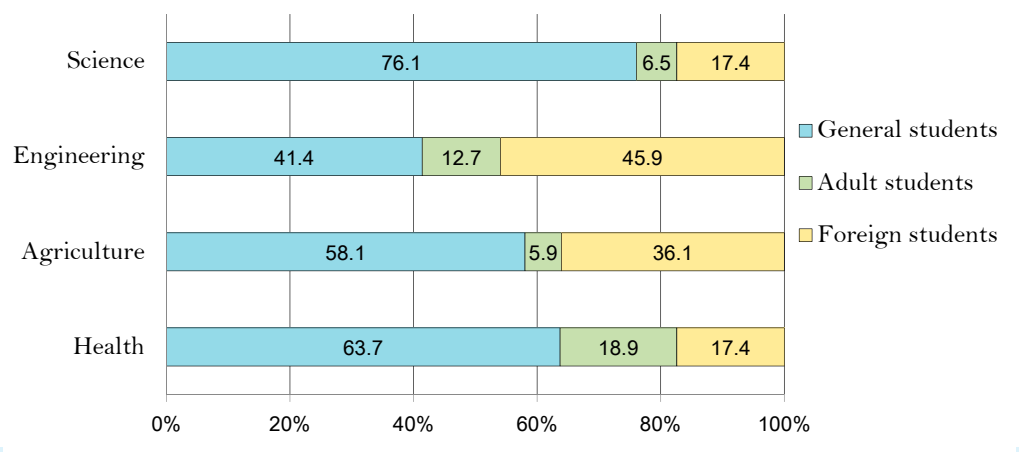
Figure 1-2-22 / Women as a Share of Newly Employed Faculty Members and as a Share of Doctoral Course Students, Broken Down by Academic Discipline



Source: *Fiscal 2013 School Basic Survey*, MEXT, FY2013 (regarding the data on doctoral students), and MEXT, FY2011 (regarding the data on female faculty members)

One reason for this large difference is the fact that a limited number of international female students are employed as faculty members. International students account for 45.9% of female doctoral students in engineering, 36.1% of female doctoral students in agriculture and 17.4% of female doctoral students in science (Figure 1-2-23). Although foreign nationals account for a relatively large share of female doctoral students in engineering, foreign women account for only 1.5% of new doctoral graduates who are employed as faculty.

Figure 1-2-23 / Breakdown of Female Doctoral Graduates by Academic Discipline

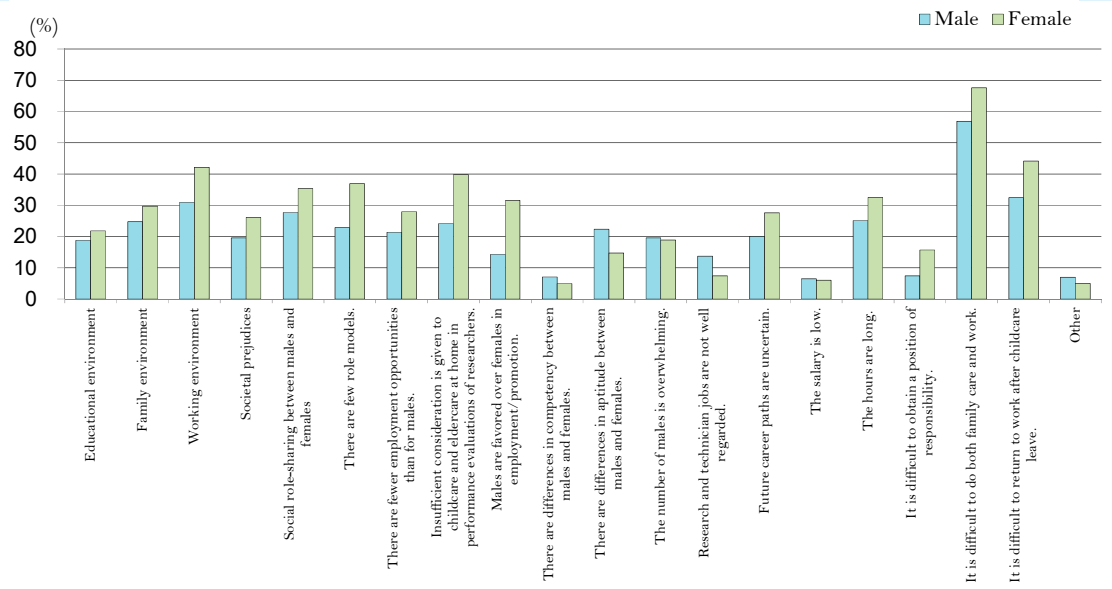


Source: *Analysis on Ratio of Women in Science in Japan*, Survey Material 209, NISTEP, May 2012

3) Problems faced by female researchers

As described above, female researchers account for a small percentage of researchers in Japan. The *3rd Survey* indicated that female researchers are unable to assume more active roles due to "difficulty in reconciling work and family life", "difficulty in returning to work after maternity leave", "unsupportive working conditions" and "lack of consideration in performance evaluations to the situation of female researchers burdened with caring for children or family members" (Figure 1-2-24).

Figure 1-2-24 / Reasons Why Women Account for Only a Small Share of Researchers



Source: *The 3rd Large-scale Survey of Actual Conditions of Gender Equality in Scientific and Technological Professions*, Japan Inter-Society Liaison Association Committee for Promoting Equal Participation of Men and Women in Science and Engineering (EPMEWSE), August 2013

(i) Work-life balance

The Association for Woman in Science (AWIS), an American association established in 1971 with the aim of eliminating discrimination against female scientists, conducted a survey [1] of 4,225 researchers worldwide. In the survey, 54% of the respondents said that work conflicted with life responsibilities at least two or three times a week. Only 52% of the respondents were satisfied with their work-life balance. This survey result shows that researchers overseas also find it difficult to achieve a balance between work and personal life.

One factor that makes it difficult for researchers to balance work with personal life is their working hours, which are longer than those in other occupations. Although wife and husband need to share family responsibilities, women actually bear a greater burden of housework and childcare; thus, they face a major challenge in balancing research and family.

The 3rd Survey mentioned above shows the average hours worked per week to be 51 hours for male researchers and 49 hours for female researchers, and the share of workers working 60 hours or longer per week to be 37% for male researchers and 27% for female researchers. According to the *Labour Force Survey* conducted by the MIC in 2013, the weekly average of work hours for those not in agriculture or forestry is 44.4 hours for males and 33.4 hours for females. It is clear that female researchers average more work hours than women in all occupations other than agriculture and forestry.

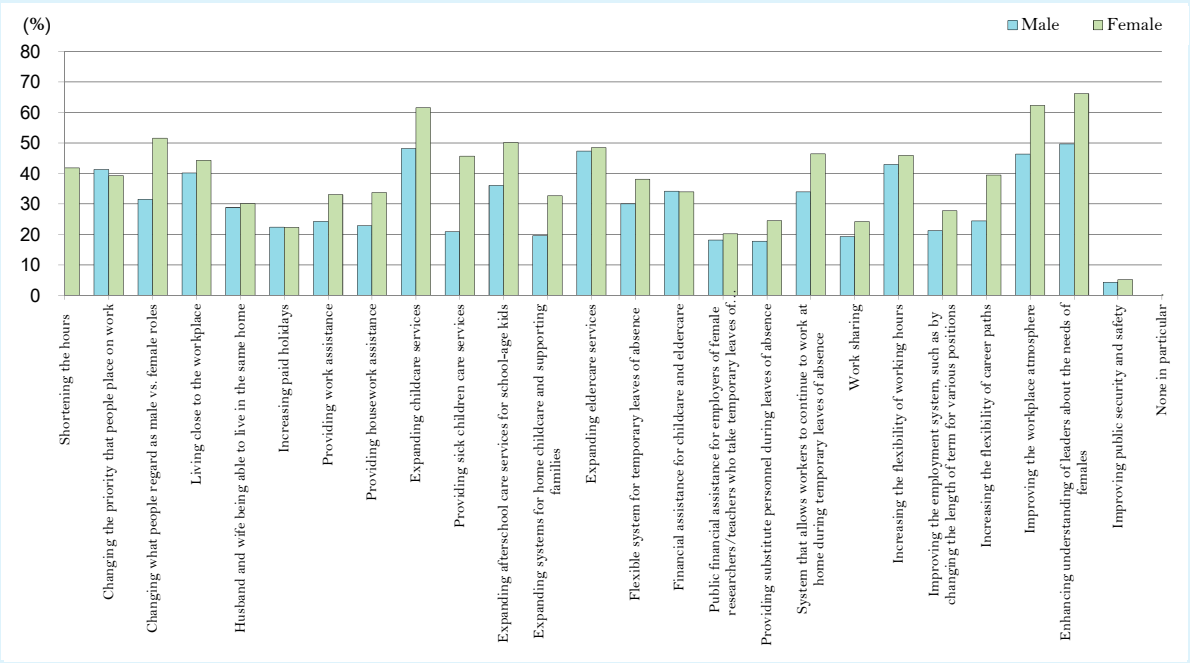
The 3rd Survey also shows that a high percentage of female researchers are married to researchers, and that about half of female researchers have lived separately from their husbands. Thus, it is very difficult for many female researchers to share the burden of childcare and other housework with their spouses.

The same survey identified requirements for work-family balance as including "theunderstanding of supervisors", "a favorable work atmosphere", "change in the awareness of gender roles", "improvement of young childcare services, after-school childcare programs and nursing-care services" (Figure 1-2-25). In *The 2nd Large-scale Survey of Actual Conditions of Gender Equality in Scientific and Technological Professions* conducted five years before the *3rd Survey*, 26.1% of male respondents and 36.0% of female respondents said "improvements in nursing-care services" were necessary. The percentage significantly increased to 48.1% and 49% for men and women respectively in the *3rd Survey*, indicating that the need has been increasing not only for childcare services but also for nursing-care services.

Stereotypes of gender roles are an issue that is also mentioned in the *Action Plan on Women's Active Participation in the Workplace* by the Japan Business Federation as a challenge that needs to be addressed toward promoting more active roles of women. Since 1997, the number of dual-income households has always been larger than the number of households with employee husbands and full-time homemakers. Universities, private companies and the entire nation need to be more aware of this change in the social environment for correcting the stereotype of "women at home, men at work" as well as the systems and practices based on this perception.

1 *The work life integration overload: Thousands of scientists weigh in on outmoded work environments, unfriendly family policies* (published in March 2012) (http://c.ymcdn.com/sites/www.awis.org/resource/resmgr/imported/AWIS_Work_Life_Balance_Executive_Summary.pdf)

Figure 1-2-25 / Requirements for Work-family Balance



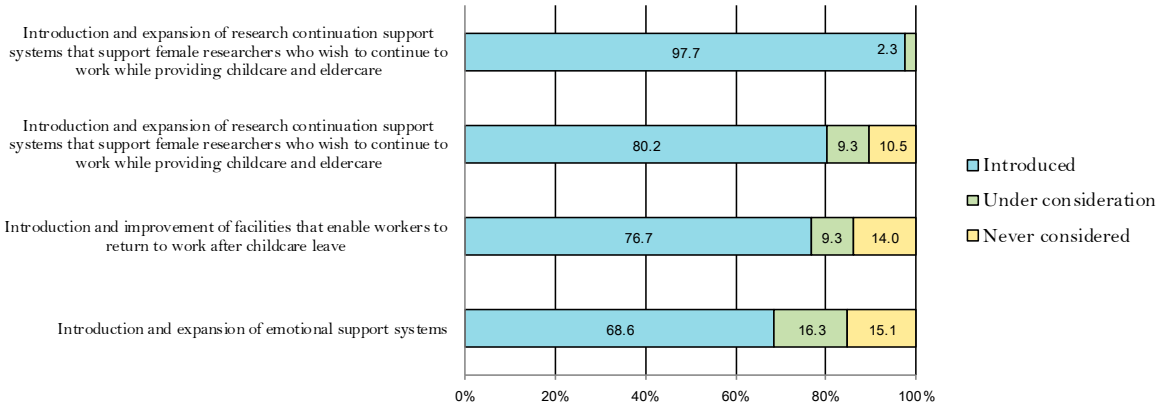
Source: *The 3rd Large-scale Survey of Actual Conditions of Gender Equality in Scientific and Technological Professions*, Japan Inter-Society Liaison Association Committee for Promoting Equal Participation of Men and Women in Science and Engineering (EPMEWSE), August 2013

Next, efforts made by universities for improving the work environment to help researchers balance work with family life are shown below.

In January 2014, the Gender Equality Subcommittee under the Research and Education Committee of the Japan Association of National Universities published the *Report on the 10th Follow-up Survey Regarding Promotion of Gender Equality at National Universities* (hereinafter: "*The 10th Follow-up Survey*"). The survey found that 97.7% of the national universities nationwide have been improving their programs for facilitating researchers' work by helping researchers to balance work with family and by making a flexible work time system available to those who are providing care to family members.

Additionally, 80.2% of the national universities have developed programs for helping researchers to continue their research while providing care to family members. This percentage is up by 10.4 points from the 9th follow-up survey released in January 2013. To facilitate a return to work after maternity leave, 76.7% of national universities have provided or improved their childcare facilities. To emotionally support female researchers, 68.6% of national universities have introduced consultation services for researchers who need to ask for advice regarding career plans, childcare, nursing-care for family members or the like. It is hoped that such support programs will be further improved (Figure 1-2-26).

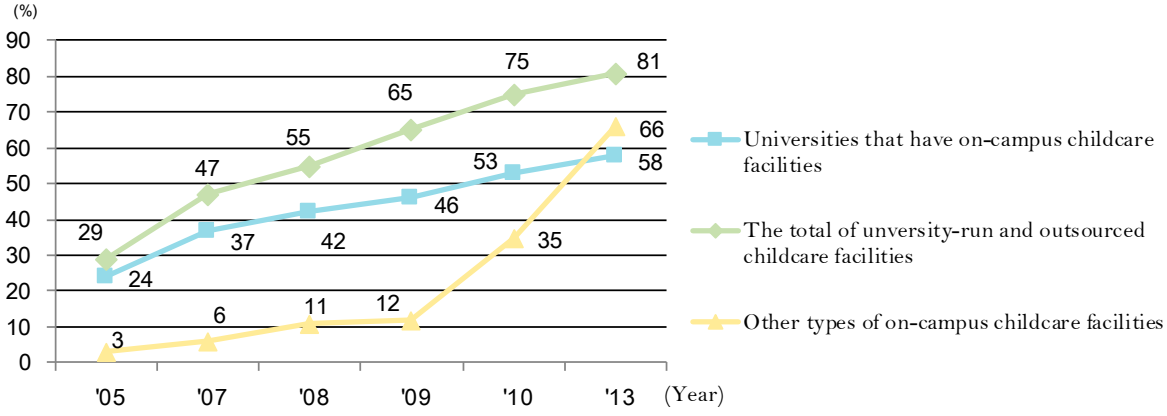
Figure 1-2-26 / Improvement of Work Environments for Researchers



Source: *Report on the 10th Follow-up Survey Regarding the Promotion of Gender Equality at National Universities*, January 10, 2014

The number of childcare facilities has been increasing with each passing year. According to the *10th Survey*, the number of national universities with childcare facilities increased from only 24 in 2005 to 58 in 2013, accounting for 67% of national universities nationwide (Figure 1-2-27). However, regarding the care of sick children, which about 50% of female respondents say is necessary (Figure 1-2-25), there are only 15 sick child day-care centers, 23 convalescent child day-care centers and 29 night child-care centers. The researchers' diverse needs for childcare have not been fully met at universities.

Figure 1-2-27 / Changes in the Percentage of National Universities with Childcare Facilities



Source: MEXT based on the *Report on the 10th Follow-up Survey Regarding Promotion of Gender Equality at National Universities*, January 10, 2014; MIC

The number of faculty members at national universities who took advantage of childcare leave programs increased from 141 in FY2000 to 401 in FY2012. However, women make up the majority (384) of the faculty members who took childcare leave in FY2012. Only a limited number of male faculty members use childcare leave programs, and women are burdened with most of the childcare.

Some researchers do not dare to take childcare leave, because they do not want to disturb the continuity of their research. Since there are researchers who have young children to care for and who wish to continue

their research as much as possible toward accomplishing good research results, the current childcare leave programs, under which researchers have to discontinue their research, do not suit the needs of these researchers. For researchers taking care of children, it is necessary to adopt more flexible work arrangements, including programs for flextime and a shorter work week (e.g., working four hours a day for five days a week).

Some researchers are not able to take advantage of childcare leave programs. These researchers say they cannot take childcare leave, out of consideration for other faculty members, because reductions in the work responsibilities of one member due to life events such as childbearing and childcare puts an additional burden on other members. They also say that it is impossible to use childcare leave programs due to a lack of understanding among co-workers.

At some universities, researchers under fixed-term employment contracts are not eligible for childcare leave programs. Because an increasing number of young researchers are employed under fixed-term contracts, as shown in Chapter 1, it is necessary to utilize childcare leave programs in a more flexible manner.

Some researchers are not able to take advantage of childcare leave programs.

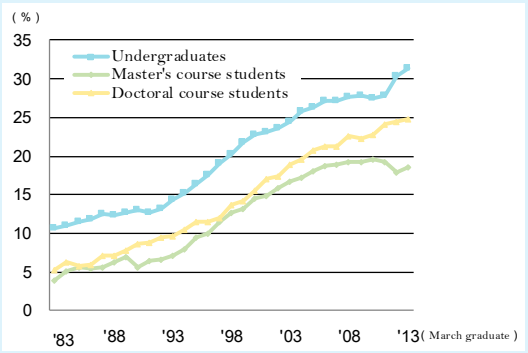
(2) Situation regarding female students

The current situation regarding future-generation researchers, namely female students at universities and high schools, is described below.

1) Situation regarding female university students

Increasing numbers of female students are majoring in the natural sciences (science, engineering, agriculture and health science). Women account for 31.4%, 18.6% and 24.8% of the undergraduates, students in master courses and doctoral students, respectively, who completed their courses in natural sciences in FY2013 (Figure 1-2-28). In the USA, female students account for 48.8%, 41.8% and 40.1% of the undergraduates, students in master courses and doctoral students in natural sciences, respectively. Thus, women account for a much greater share of students in the natural sciences in the USA than in Japan.

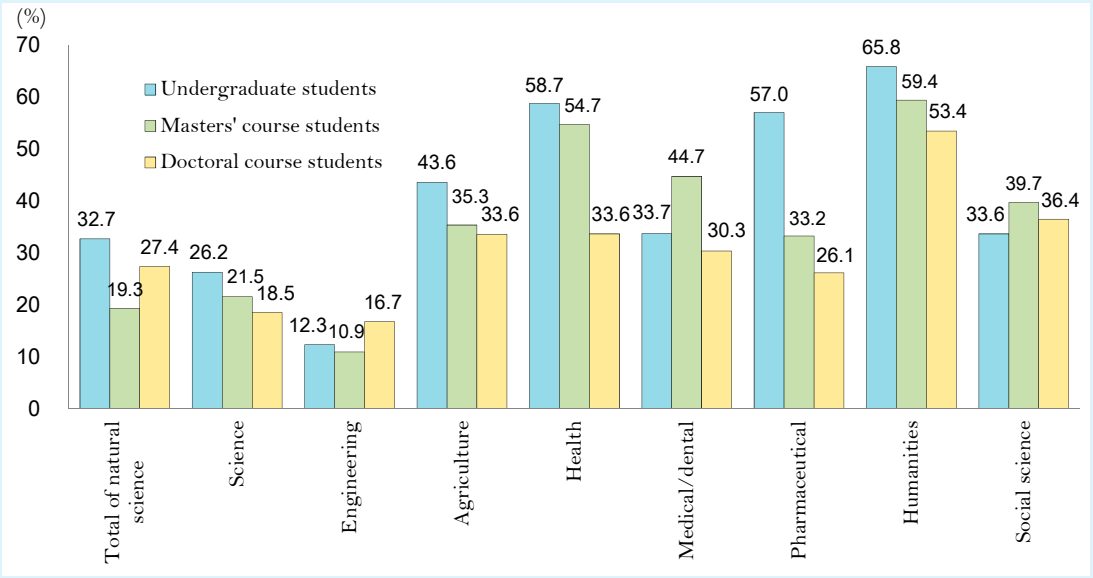
Figure 1-2-28 / **Changes in Women as a Share of Students Who Have Completed Courses in the Natural Sciences (i.e., Science, Engineering, Agriculture and Health Science) in Japan**



Note: "The natural sciences" includes science, engineering, agriculture and health science
Source: MEXT based on the *School Basic Survey*

The share of women majoring in the natural sciences varies by academic discipline, and relatively few female students major in science and engineering (Figure 1-2-29).

Figure 1-2-29 / Women as a Share of Undergraduates, Students in Master's Courses and Doctoral Students in the Natural Sciences, by Discipline



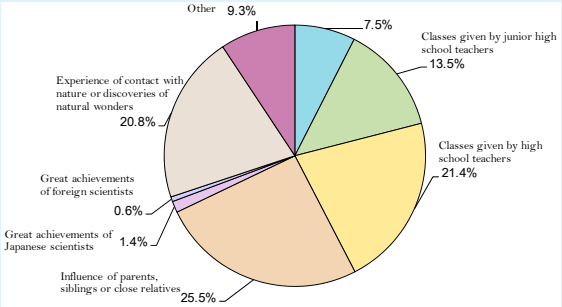
Note: "The natural sciences" includes science, engineering, agriculture and health science
Source: MEXT based on the *Fiscal 2013 School Basic Survey*

2) Situation regarding female high-school students

(Career options)

A questionnaire survey [1] of female students majoring in the natural sciences shows that many of these students chose their major because they had been inspired by family members or high-school teachers. This survey result suggests that people close to student girls, such as family members and school teachers, strongly influence how girls decide what path to take (Figure 1-2-30).

Figure 1-2-30 / Reasons Why Female Students Major in the Natural Sciences



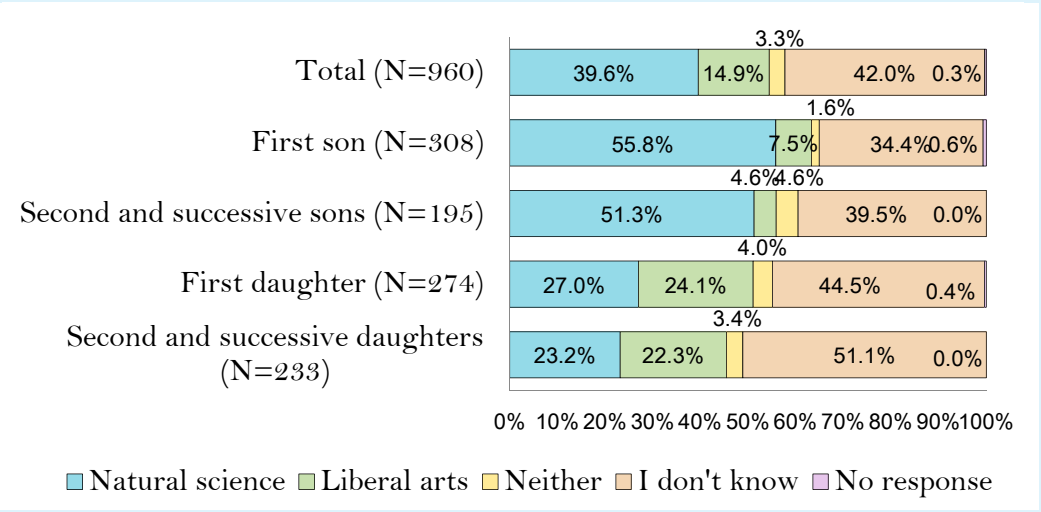
Source: *Survey of Female Students' Satisfaction with Science Majors*, Nihon L'Oréal K.K. (June, 2011) [n=1,000]

Parents, who tend to have great influence on female students' choice of majors, are not provided with sufficient information for decision-making. The Central Council for Education of MEXT published the report *Career Education and Vocational Education in the Future* in January 2011. This report indicates that parents do not have access to the career information that is necessary to help their children choose a career.

According to the web version of the *White Paper on Elementary Students* published by Gakken Holdings Co., Ltd. in 2012, more than 50% of parents hope that their sons will take science courses, whereas only about 25% of parents hope their daughters will major in sciences. These data suggest that many parents are likely to have the persistent idea of "men for science courses, women for humanities courses" (Figure 1-2-31).

1 The *Survey of Female Students' Satisfaction with Science Majors* was conducted by Nihon L'Oréal K.K. in June 2011 on women in the 18-29 age bracket majoring in natural sciences at universities nationwide.

Figure 1-2-31 / Courses That Parents Hope Their Children Will Take in High School and at University



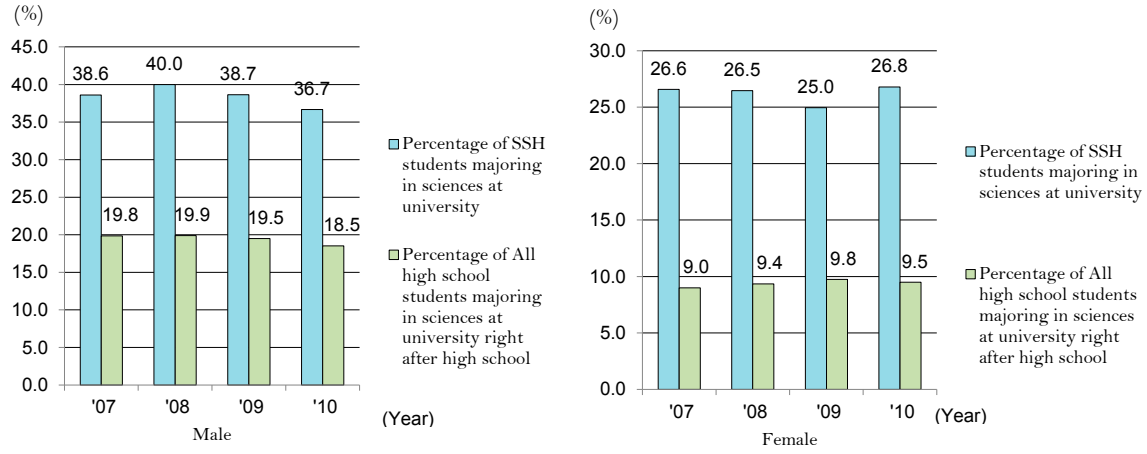
Source: Web version of the *White Paper on Elementary Students*, Gakken Holdings Co., Ltd., (based on a survey conducted in July 2012)

As indicated in the *Action Plan on Women's Active Participation in the Workplace*, female students also have preconceptions about students with science majors, presuming that these students need to spend many nights doing research in the lab or that they are morose and only interested in research. It is partly because of these preconceptions that female students are likely to hesitate to major in sciences.

It is especially necessary to get rid of the image associated with engineering, which is generally regarded as a discipline in which men specialize. In 2013, the National Women's Education Center of Japan held the Summer School for High and Junior High School Girls 2013, at which a questionnaire survey was conducted. The Japan Society of Civil Engineers, which participated in the event, asked junior high and high school girls about their image of civil engineering. Some girls were found to have a stereotypical image, associating civil engineering with men's work and physical labor.

The percentage of high school girls who go on to take science courses is higher at high schools that focus on math and science education than at other high schools. While the percentage of boys at "super science high schools" (SSHs) who take science courses at university is twice the national average for high school boys, that percentage for girls at SSHs is 2.8 times the national average for high school girls. Studying at a SSH versus at a conventional high school affects girls more than it affects boys. These data suggest that the enhancement of math and science education at high schools influences the number of female students who are willing to take science courses (Figure 1-2-32).

Figure 1-2-32 / Percentage of SSH Students Majoring in Sciences at University, by Gender



Note: The figures are provisional.
Source: NISTEP based on the *School Basic Survey* (MEXT) and the *Report on the Data from a Survey on the Performance of Super Science High Schools* (Japan Science and Technology Agency)

3) Situation regarding science education

Currently, women account for only a small share of researchers in the natural sciences. To increase the number of female researchers in those disciplines, education at elementary, junior high and high schools needs to encourage girls to take an interest in the natural sciences.

However, the *Report on the Survey of Science Education at High Schools FY2008* (March 2010), the *Prompt Report on the Survey of Science Education at Junior High Schools FY2012* (September 2013) and the *Report on the Survey of Science Education at Elementary Schools FY2010* (June 2012), which were released by the Japan Science and Technology Agency, show that roughly 30% of the high schools, 20% of the junior high schools and 40% of the elementary schools surveyed had secured no budget for the procurement and maintenance of equipment necessary for science education for the fiscal years when the surveys were conducted. In FY2012, 73% of the junior high schools that responded to the survey reported not having a science club, marking a slight increase from FY2008.

According to the *Prompt Report on the Survey of Science Education at Junior High Schools FY2012*, while 70% of junior high school science teachers said they had adequate knowledge of scientific experiments and observation, only about 30% said they had enough skills to instruct students on independent scientific research projects, indicating that science teachers are not confident about giving instructions on independent research.

Thus, desirable environments are not in place for cultivating the potential talent of young students who take an interest in natural sciences before entering university.

A Mito Second High School student receiving the MEXT Minister's Award
Courtesy of MEXT

4) Results achieved in science by female students at high schools and universities

Although women account for only a small share of

students majoring in the natural sciences, many female students have achieved excellent research results.

Under the Ikushi Prize program of the Japan Society for the Promotion of Science, outstanding doctoral students who are expected to contribute to Japan's future scientific advancement are formally recognized. Of the 18 prize winners in FY2013, six were female, showing that female doctoral students are achieving excellent results.

Female high school students are also active in conducting ingenious research. In FY2011, female members of the mathematical science club at Mito Second High School, an SSH in Japan, made a splendid achievement. The results of a chemical experiment performed by them appeared in *The Journal of Physical Chemistry A*, a scientific journal published by the American Chemical Society.

At an SSH student research presentation meeting held in August 2013, a female student from Mito Second High School received the MEXT Minister's Award for research on the breeding season of two Japanese brown frog (Rana japonica) species.

(3) Future directions of efforts

In light of the analysis results described above, enhanced efforts are required in the following three areas.

First, it is necessary to promote active participation by female researchers in leadership positions. Young researchers and female students aspiring to be researchers will view senior female researchers as role models when female researchers in leadership positions increase in number to exert a strong presence. Consequently, more women will aim at taking senior positions.

The report *Women in Scientific Careers* cited above states, "Emphasis is often placed on inspiring young girls to choose science ... but such efforts for securing distinguished women researchers are wasted if women are then disproportionately disadvantaged in scientific careers compared to men", and "Universities and other HEIs have ultimate responsibility for employment conditions and the greatest obligation to improve STEM careers for all researchers."

Programs for supporting career development, including mentoring schemes, are also important for leadership training. For example, the ADVANCE program of the National Science Foundation (NSF[1]), which aims at increasing the representation and advancement of women in academic STEM careers, provides career support programs, such as mentoring and leadership development, by senior faculty members.

Second, support to researchers needs to be based on adequate consideration of their work-life balance. Specifically, work-life balance support to researchers, the improvement of research environments and efforts to increase awareness of the needs of female researchers at the workplace should be implemented by taking into account the work-life balance of researchers.

Support should particularly focus on arrangements for helping highly qualified, motivated researchers reintegrate into the workplace after suspending their research due to life events. *The 3rd Basic Plan for Gender Equality*, approved by the Cabinet in December 2010, also stresses the importance of giving support to female researchers so as to ensure that they can return to research after taking maternity leave.

1 The NSF is an independent U.S. government agency responsible for promoting science and engineering through basic research programs and education projects.

Because discontinuation of research makes it difficult for researchers to return to the workplace, support should also be provided to those who wish to keep doing part of the research work while taking maternity leave by giving them opportunities to attend scientific meetings and by enabling them to access necessary information at home via information technology environments.

Third, the development of future-generation female researchers is necessary. To increase the number of female researchers in the natural sciences, education in elementary, junior high and high schools needs to encourage girls to take an interest in the natural sciences. Toward such education, the following specific measures are required:

- Training teachers to be able to communicate the appeal of the natural sciences to students by giving appropriate instruction regarding advanced research projects in science education at elementary, junior high and high schools; Improving the educational environments of these schools.
- Providing adequate input to parents regarding career paths available to students majoring in the natural sciences.
- Providing girl students and their parents with opportunities to communicate with female university students and researchers in the natural sciences, so that these girls and parents can be informed of the advantages of majoring in science as well as of the career paths open to female researchers.

(4) Specific projects

Universities in Japan have been making efforts based on the above-mentioned measures. Major efforts and results are outlined below.

1) Supporting activities for female researchers

MEXT has been implementing Supporting Activities for Female Researchers for the purpose of assisting universities that are improving environments to help female researchers achieve a balance between work and major life events such as childbirth, childcare and nursing-care for family members.

Specific examples of efforts made by the organizations selected for this program are shown below.

[Case examples]

(i) Support for achieving a balance between work and major life events such as childbirth, childcare and nursing-care for family members

- Providing research administrators to female researchers who have difficulty in finding time for research due to the need for childcare or nursing-care for family members.
- Adopting a program of a shorter working week for researchers caring for children. Under this program, researchers can work in multiple patterns of working hours, ranging from 19 hr 35 min to 29 hr 35 min per week during a period of more than one month but less than one year before their children enter elementary school.
- Establishing after-school day-care centers on campus to help solve problems facing working mothers with first graders.

(ii) Consultation services for female researchers

- Developing a system of global mentorship, whereby female researchers playing active roles internationally serve as mentors, providing advice to young female researchers individually

and/or at networking opportunities.

(iii) Incentive awards for outstanding female researchers

- Offering incentive awards to female researchers in the three categories of research achievements, educational activities and regional/international contributions, for the purpose of motivating female researchers, who have diverse careers and experiences

(iv) Education of future-generation researchers

- Appointing graduate students in the natural sciences as "Science Angels" who speak at elementary, junior high and high school seminars.

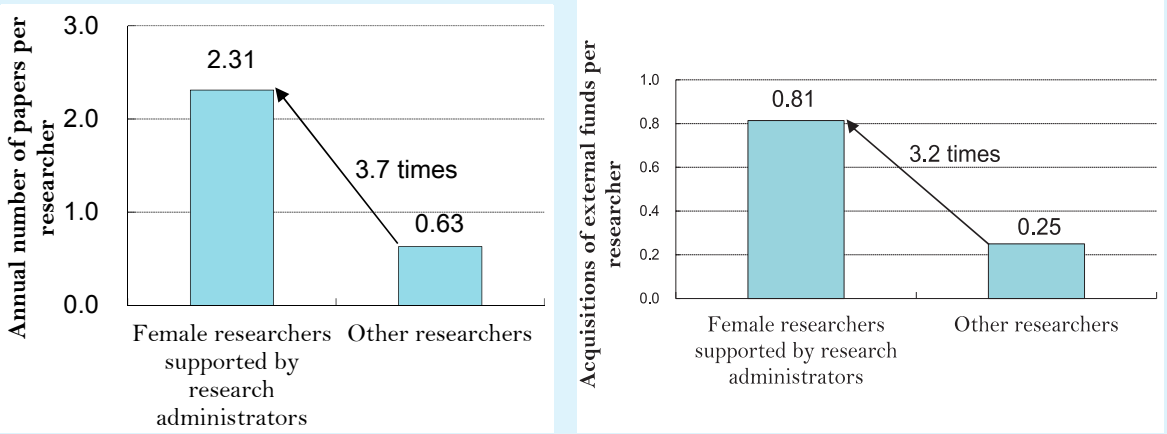
[Achievements]

The results of the Program to Support Research Activities of Female Researchers are as follows.

(i) Performance enhancements for female researchers with the help of research administrators

When supported by research administrators, female researchers perform remarkably better than female and male researchers without such support, in terms of the number of publications and the amount of external research funding. The use of research administrators has helped female researchers to work more actively (Figure 1-2-33).

Figure 1-2-33 / Publications and External Research Funds: Female Researchers Supported by Research Administrators vs. Other Researchers

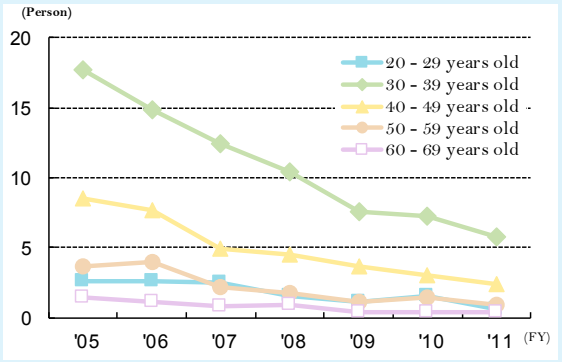


Source: Japan Science and Technology Agency

(ii) Reduced turnover of female researchers experiencing major life events

Regarding the 55 organizations that were supported by the MEXT program *Supporting Activities for Female Researchers* funded by the Special Coordination Funds for Promoting Science and Technology from FY2006 through FY2010, the annual average number of female researchers who quit their jobs for reasons other than mandatory retirement decreased to 10.1 in FY2011 from 34.0 in FY2005, the year before the program started. A particularly remarkable decrease is found in female researchers in their 30s who are raising children; The number of those who quit their jobs decreased from 17.7 in FY2005 to 5.8 in FY2011 (Figure 1-2-34). These data indicate that adequate support to female researchers experiencing major life events helps to reduce their turnover rate.

Figure 1-2-34 / Changes in the Number of Female Researchers Leaving Their Jobs, Broken Down by Age



Source: the Japan Science and Technology Agency

2) Program to accelerate reforms in the training system for female researchers

MEXT has been implementing the *Program to Accelerate Reforms in the Training System for Female Researchers*, with the aim of fostering female researchers in science, engineering and agriculture at a faster rate than at present, because woman account for only a small share of the researchers in these academic disciplines.

Specific examples of efforts made by the organizations selected for this program are shown below.

(i) Consultation services for female researchers

- Multiple mentoring programs are developed for newly employed female researchers. In addition to each department's mentoring program, a system for mentoring support was established by appointing mentors from among female professors throughout the university. These mentors provide advice and guidance regarding issues shared by female researchers in relation to research work, career progress, childcare and the like.

(ii) Research capacity building for female researchers

- Seminars are held, to help building female researchers' capacity for organization/ research control, leadership, procurement of research funds and transdisciplinary research integration.
- A system is developed for supporting female researchers who aspire to leadership positions by providing financial aid for traveling abroad to attend international academic meetings and by helping them to submit papers to international scientific journals.

3) Independent efforts by universities to enhance female researchers' active roles

Specific examples of efforts made independently by universities to enhance female researchers' active roles are shown below.

(i) Support to female researches for achieving a balance between work and major life events such as childbirth, childcare and nursing-care for family members

- Introducing a short-time work system that allows female researchers to flexibly work 30 hours or longer per week. [Tokyo Women's Medical University]
- Introducing a tenure-track system that allows female clinicians to work for a shorter time (28 hours or longer per three days a week). [Tokyo Women's Medical University]
- Providing a "special extra term of office" of less than 2 years to female researchers who take maternal leave and applying such an extra term. [Kyushu University]
- Developing a system that allows female researchers who take extended maternity leave to employ a lecturer or an assistant professor to support their jobs for a period longer than the length of the leave (i.e., about 3 years). [Kyushu University]

(ii) Support for return to work

- Assigning postdocs to laboratories that have female researchers on maternity leave, in order to continue the research of these researchers. [Tokyo University of Agriculture and Technology]

(iii) Support for research couples

- Developing a program that allows partners of newly employed researchers to belong to the Support Office for Female Researchers under fixed-term contracts so that they can engage in their own research while also working for the Support Office, with the aim that that research couples can live together and continue their respective research. [Hokkaido University]
- Establishing a system that enables researchers to take leave to accompany partners who are transferred or who are studying overseas. [Iwate University]

(iv) Positive actions for the employment of female researchers

- Developing a scheme for providing incentives to departments that hire new female faculty members. The incentives, which cover half the payroll costs borne by these departments, are paid out of the university's overall budget for personnel expenses under the university president's control. [Hokkaido University]
- Establishing a system that allows for the public recruitment and employment of female researchers in positions one level higher than the positions that candidate researchers currently hold (e.g., an assistant professor can be employed as an associate professor) by covering the difference in payroll costs between the two positions with university's budget. [Iwate University]

4) The Restart Postdoctoral Fellowship (RPD) program

The Japan Society for the Promotion of Science has been implementing the Restart Postdoctoral Fellowship (RPD) program since FY2006, in order to provide research incentives to male/female researchers who have discontinued their research due to childbearing/childcare. The aim is to help them to return to research work. This program makes it possible for researchers who have suspended their research for childbearing/childcare to engage themselves fully in research again without feeling financially insecure. Some researchers who have completed the term of this fellowship program are now achieving excellent research results in tenured or other stable positions.

5) Program for supporting female students in choosing science courses

For the purpose of fostering the development of future-generation female scientists, JST has been implementing the *Program for Supporting Female Students in Choosing Science Courses*. Under this program, junior high and high school girls are given opportunities to communicate with female S&T researchers, engineers and university students, and to take part in experiment classes and school visit programs. Specific examples of efforts made under this program are shown below.

[Case examples]

(i) Summer School for Junior High and High School Girls

Since FY2005, the National Women's Education Center of Japan has been holding the annual Summer School for Junior High and High School Girls, a 3-day study trip. Networks of participants in this summer school, namely female researchers, engineers, graduate students, undergraduates and junior high and high school students, have expanded, and some student participants in the past are now helping in the planning and management of the summer school programs as teaching assistants.

In addition to the residential hands-on science program of the summer school, student staff planned a new program in FY2013. This new program utilizes Saien-sugoroku, a game for learning about S&T careers that was developed as a participatory learning aid to help junior high and high school girls to deepen exchanges with female scientists and engineers. Saien-sugoroku is a board game. Playing the game by doing science quizzes created by the student staff, girls can simulate the career paths of female scientists. In the game, career paths start for girls who have just graduated from the summer school. Players simulate various experiences specific to female scientists, including choosing a university and careers, marriage and childcare. This game aims to help young girls develop a clear vision of the hopes and life plans of female scientists, and to encourage these girls to major in science and technology.

In conjunction with programs for youth, programs were also developed for parents with the aim of promoting parents' understanding of science majors. Parents are given opportunities to learn and think about the long-term life plans of their daughters and about gender equality. Teachers from junior high and high schools engage in group work with university faculty members, toward enhancing mutual cooperation. Through these programs, junior high and high school students who might be hesitating to major in sciences can visualize their future, and school teachers as well as parents can access the information that they need in order to give advice to young students.

(ii) Kansai Science School for Junior High and High School Girls

Kansai Science School for Junior High and High School Girls is a large-scale project supported by regional partnerships. National universities and technological colleges in the Kansai region, including Kyoto University, Osaka University, Kobe University, Osaka Prefecture University and Nara Women's University, take part in this project, and researchers and students from these universities contribute to this project as executive committee members, lecturers and mentors. Kansai Science School started in FY2006, and the cooperating universities and colleges take turns acting as the secretariat, with 1-year terms. Every year, about 600 female junior high and high school students participate in this science school, performing experiments, attending lecture meetings of female researchers who are role models, visiting research institutions, making exchanges with female researchers and taking part in Science Cafés, where students present their experiment results. In recent years, the number of repeat participants in the Kansai Science

School has been increasing, as has the number of schools that regularly send students to the Kansai Science School. It is taking root in the Kansai region as a program for junior high and high school girls who are interested in specializing in science and technology.

(iii) Programs for supporting junior high and high school girls in science (Come, Future Scientists, and Visualize Your Future!)

In cooperation with Suzuka University of Medical Science, Toba National College of Maritime Technology and the Gender Equality Office of Suzuka City, Suzuka National College of Technology has been providing various programs to junior high and high school girls, their parents and teachers so that they may meet and listen to many female scientists and understand diverse professions. These programs aim at eliminating concerns that female students have about their future as science majors. The annual summer program consists of Part 1, in which female lecturers who are invited from the kinds of businesses and disciplines in which women scientists are in high demand, speak to all participants, and Part 2, in which participants are divided into small groups so that they may listen to lecturers about occupations in which the participants are interested.

In FY2013, 13 lecturers were invited from diverse scientific fields to join in seven small groups of participants for discussion. In the discussion meetings, views were exchanged between lecturers, as well as between lecturers and participants. The lecturers served as role models and shared their experiences with participants.

6) Support programs for science and mathematics teachers

JST has been implementing the *Support Programs for Science and Mathematics Teachers*, with the aim of making science and math classes more appealing to students by capitalizing on advanced science and technology and on the social implications of science and technology. These programs help to foster teachers with excellent competence in teaching science and mathematics, and they help in the development and effective use of teaching materials based on the most advanced S&T knowledge. The support programs include, for example, Science Leaders' Camp, at which science teachers stay at leading research institutes for lectures and hands-on sessions for the purpose of learning effective skills for teaching talented students, toward their development, and for the purpose of helping to build inter-regional networks of teachers.

Riko-chan
Courtesy of the Cabinet Office

7) The Rikou Challenge

The Gender Equality Bureau of the Cabinet Office started the *Rikou Challenge* (abbr.: *Riko-challe*) website (http://www.gender.go.jp/c-challenge/index.html) to help female university and high-school students who are interested in studying science and engineering (S&E) to have a concrete image of their future careers before they choose their majors. Stories about female scientists and engineers, as well as ongoing programs at private companies and universities featuring education and research in diverse S&E disciplines, are posted on this website. The *Messages from Seniors* on this website contains information that encourages

female students to develop familiarity with S&E. These messages include the reasons why senior female scientists chose S&E disciplines, the appeal of the work they currently engage in and advice to female students.

(5) Future efforts that are hoped for

MEXT and other organizations have been implementing various programs for facilitating active participation by female scientists and for increasing the number of female researchers. However, as described above, women still account for only a small share of researchers in the natural sciences and for only a small share of university presidents, professors and other senior positions. Not a few female researchers are forced to give up pursuing research careers due to the difficulty of balancing work with family life.

Support programs are currently available to female researchers so that they may continue their research while bearing and raising children or caring for family members and so that they may return to work after maternity/nursing leave. Additional efforts are required to foster future-generation female scientists. In this regard, efforts for helping female researchers to play more active roles should be accelerated. For this purpose, it is necessary to help female researchers to balance work with major life events, to enhance the research capacity of female scientists, to advance systemic reforms and to increase support programs so that female scientists can exercise stronger leadership in research.

The development of a society in which women's potential is fully unlocked is an important pillar in the *Review Guidelines for the Progress of the Growth Strategy* approved by the Industrial Competitiveness Council in January 2014. The following February, MEXT established a task force for promoting more active roles of women. Enhancement of the support provided to female researchers in the future is outlined below, taking into account the deliberations of the task force.

1) Promoting active roles of female leaders

Female leaders' active roles help to change the awareness of the research community and help to increase the diversity of research activities. Based on this understanding, universities and private companies need to actively appoint distinguished female researchers to senior positions, such as professors and R&D supervisors.

The Fourth Science and Technology Basic Plan, decided by the Cabinet on August 19, 2011, set numerical targets for women as a share of newly employed researchers by discipline (i.e., 20% in science, 15% in engineering and 30% in agriculture), but these targets have not been achieved. To foster the development of female leaders in these disciplines, women should be increased as a share of researchers in science, engineering and agriculture, and excellent female researchers should be actively appointed to senior positions.

Industries recognize the importance of highly motivated, talented female researchers in science and engineering. On February 18, 2014, the Japan Business Federation announced the proposal *Toward Strategies for Fostering Human Resources in Science and Engineering*, which stated "Although men heavily outnumber women among Japanese researchers in science and engineering, it is critical to ensure the diversity of researchers in order to capitalize on the wisdom of diverse human resources toward the creation of innovation". It is hoped that private companies will disseminate information about women's

active roles in a way more visible to the public and will clearly publicize the career paths that are available to women for senior positions.

It is essential to include diverse career options, in addition to career paths as researchers, in the demonstration of career paths for female scholars in science and engineering. The *Action Plan on Women's Active Participation in the Workplace*, announced by the Japan Business Federation, indicated that students tend to have a distorted image of careers available to students who major in S&T. They are not informed that private companies offer a broad range of possibilities that go beyond careers as technicians and researchers. In this respect, it is necessary to provide students with opportunities to have a correct understanding of the careers available to scientists and engineers.

2) Improvement in the use of research funds and the like by taking into account the work-life balance of researchers

When highly motivated and talented researchers have no choice but to discontinue their research, such as when it becomes difficult for them to continue work in the midst of major life events, certain arrangements should be in place to make it possible for these researchers to continue research or to return to work after taking leave from their jobs. Specifically, it is necessary to enable more flexible use of competitive funds according to the researchers' requests, to provide support to the researchers, to improve research environments and to change how people in the workplace think.

Regarding competitive funds, for example, only a limited number of research programs allow them to be used flexibly by researchers undergoing major life events. Pioneering examples of such programs are the *JST Strategic Basic Research Programs* (*Creation of New Technological Seeds*)[1]. Independent researchers taking part in these research programs can extend their research period by up to one year during a major life event. When the leader of a research program needs to discontinue research due to a major life event, a researcher eligible to assume the leadership can continue the research program in place of the leader.

For researchers who need to discontinue their research during major life events, the possible impact of discontinuation on their research must be minimized and researchers' return to work must to be facilitated. To this end, it is necessary to ensure the continuation of research by hiring research support personnel and to extend the period of financial support for the research.

It is hoped that support will be provided to researchers in line with the circumstances of each researcher, so that they can continue their research in a more flexible way.

3) Programs for providing hands-on experience and encouraging students to develop familiarity with cutting-edge science and technology

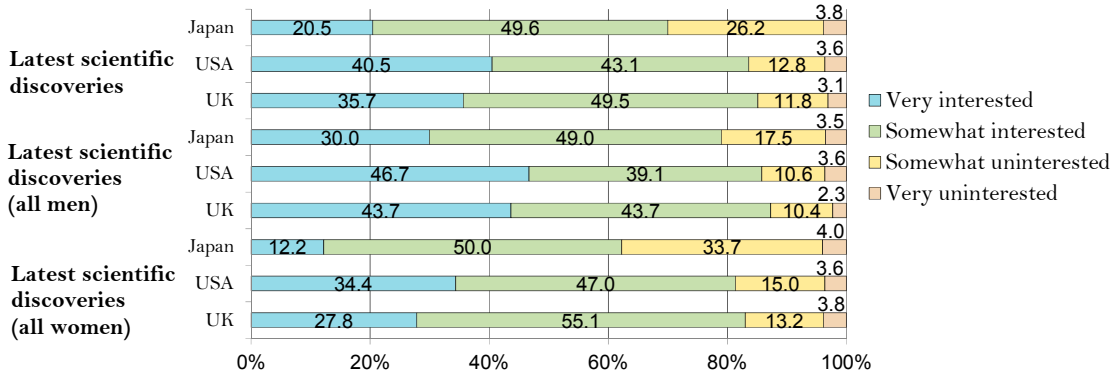
As previously stated, elementary, junior high and high schools do not have sufficient budgets for scientific experiment classes, and they are not well-prepared for getting students interested in science and for developing the abilities of students who are interested in science. The improvement of school facilities is required in order to get students interested in learning science from a young age.

When female students make a career choice, they are often influenced by those close to them. However,

1 Strategic Basic Research Programs: These are JST programs for the promotion of strategic basic studies leading to the creation of innovation, or technological "seeds". Decisions on the national strategic objectives that these basic studies aim at achieving as well as the study areas are made in a top-down style with a view to meeting needs in society and industry. Research proposals are accepted from researchers at universities and the like for conducting studies through the formation of time-limited consortia that cut across institutional boundaries (i.e., the virtual institute system).

those around female students are unlikely to have great interest in S&T, partly because people's level of interest in S&T in Japan is lower than in other countries (Figure 1-2-35).

Figure 1-2-35 / Level of Interest in the Latest Discoveries in Science and Technology, Broken Down by Gender

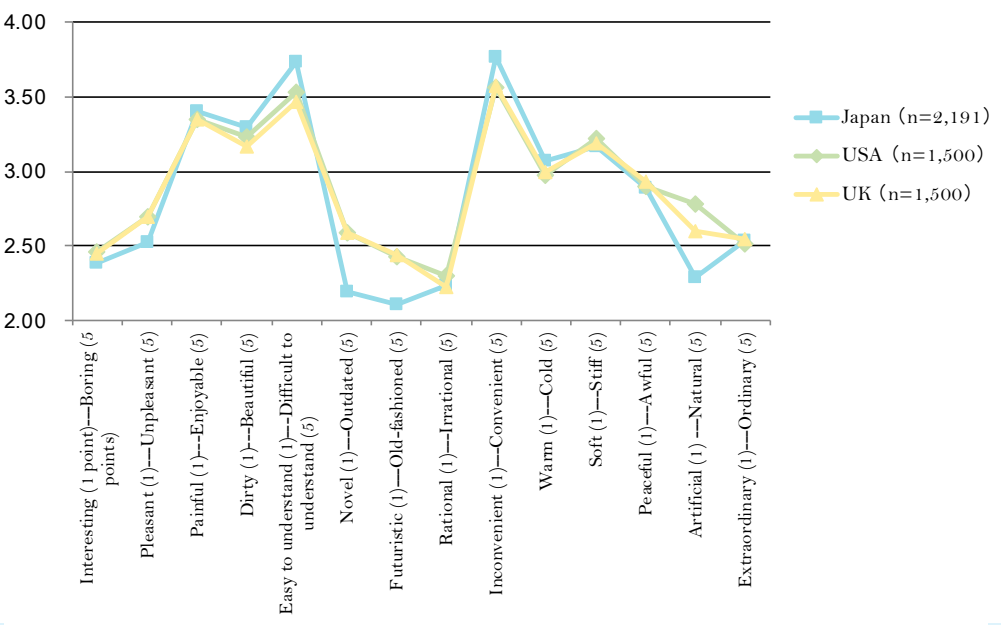


Note: Japanese men/women: n=1,020/1,171, American men/women: n=745/755, British men/women: n=742/758
Source: *International Comparison of the Public Attitudes towards and Understanding of Science and Technology – Comparative Study of Internet Survey in Japan, the United States of America, and the United Kingdom*, Survey Material 196, NISTEP, March 2011

One reason why people's level of interest in S&T is lower in Japan than in the USA and the U.K. is that Japanese people tend to think S&T has little to do with their lives, even though they recognize the significance of S&T. A comparison of the image of S&T held by Japanese, American and British people shows that the image held by Japanese is both positive and negative: They regard S&T as something that is advanced, novel, futuristic or convenient, but they also consider S&T to be artificial and difficult to understand (Figure 1-2-36).

Increasing the number of children who take a deep interest in learning science and math is essential for fostering the development of future-generation female researchers. To this end, S&T should be made something that parents can relate to, because they have the most influence on their children's thinking, particularly for girls. Through the cultivation of greater interest in S&T, parents will have more opportunities to talk about S&T with their children at home; thus, the children will be able to develop familiarity with S&T.

Figure 1-2-36 / People's Image of Science and Technology



Source: *International Comparison of the Public Attitudes towards and Understanding of Science and Technology – Comparative Study of Internet Survey in Japan, the United States of America, and the United Kingdom*, Survey Material 196, NISTEP, March 2011

The development of familiarity with S&T also requires efforts by teachers at elementary, junior high and high schools; by faculty members and students specializing in natural sciences; and by private companies. They need to inform the public of various research results, applications of the research results and contributions of these applications to society in an understandable and appealing way. For instance, IC cards, which people use almost every day, depend on electromagnetic waves for wireless data communications, but users are rarely conscious of the most advanced S&T utilized in the cards. Awareness of S&T that is applied to personal items can spark new interest in S&T.

To disseminate information about applications of S&T, it is important to increase opportunities for the public to see and exchange views with researchers engaging in studies of leading-edge S&T, in addition to the opportunities one has to individually find out information on the Internet, on TV and in newspapers. Of the various means for accessing information about S&T, the Internet, TV and newspapers are the means that people most frequently depend on and are relatively satisfied with. Current methods of sending information are unidirectional. We need to increase bidirectional information transmission in the future.