6 Fostering Global Level Young Researchers

Fostering young researchers is important not only from the aspect that the research results of the forerunners that have accumulated so far can be relayed to the next generations, but also that having the participation of creative minds can enhance and vitalize research itself. In addition, it is critical to widen the opportunities for human resources with highly specialized capabilities to work not only in universities and public research institutions, but also in a wide variety of sectors in and out of the country. To that end, it is hoped that higher education and research institutions which have a role of nurturing human resources, can send talented people who can make contributions to the solutions of various social problems into society, by exchanging information with the industries or establishing international partnerships.

(1) Importance of Fostering Young Researchers

The joint research team of the Institute of Innovation Research, Hitotsubashi University and the National Institute of Science and Technology Policy conducted a survey "Knowledge Creation Process in Science" in November, 2010. According to the survey, research projects that yielded the top 1% highly cited research papers are highly related to patent applications, joint research, commissioned research, and the establishment of start-up firms, indicating a high potential of contributing to innovation (Table 1-1-23). Furthermore, the survey also shows a high percentage of postdoctoral fellows as the first authors of the top 1% highly cited research papers (Figure 1-1-24). It can also be observed that authors in the top 1% highly cited research papers are more diverse in terms of combination of the origin of birth and of specialized fields of researchers. (Figure 1-1-25).

For further advancement in Japanese science, technology and innovation, participation of diverse human resources such as foreigners in research projects is required, and the mobility of researchers across organizations and countries needs to be enhanced. Especially, based on the fact that young researchers greatly contribute to the production of the top 1% highly cited research papers, to provide them with more opportunities for overseas training, and to work independently and demonstrate their abilities is essential.

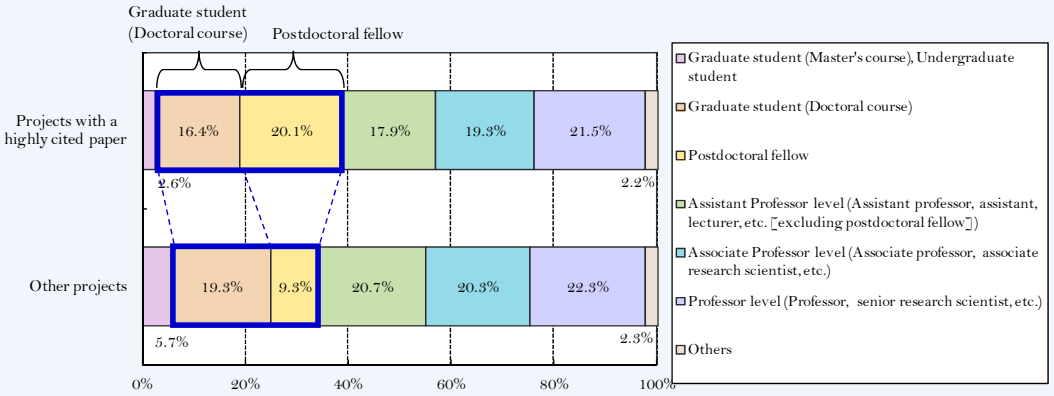
Table 1-1-23/Output and Impact of Research Projects

	Projects with a highly cited paper			Other projects				
	Projects that resulted in the output/impact	Responses	Percent(a)	Projects that resulted in the output/impact	Responses	Percent(b)	(a)/(b)	
Commissioned research and Joint research	428	539	79%	853	1,403	61%	1.3	<*>
Patent application	236	564	42%	350	1,502	23%	1.8	<*>
Technical guidance	202	539	37%	385	1,403	27%	1.4	<*>
Licensing or assignment	77	563	14%	117	1,494	8%	1.7	<*>
Internal commercialization	61	564	11%	155	1,507	10%	1.1	
Standard	59	562	10%	110	1,507	7%	1.4	<*>
Start-up firm	15	563	3%	27	1,513	2%	1.5	<*>

Note: 1. Projects with highly cited papers: research projects that produced one or more top 1% highly cited research papers.
Other projects: research projects that produced ordinary papers (not among the top 1%).
2. Commissioned research/Joint research and technical guidance: Responses with one or more institution were counted.
3. Patent application: The number of "Yes" to the query "Led to patent application?" was counted.
4. Licensing and assigning: "Licensed" or "Assigned" was counted.
5. Internal commercialization: "Commercialized" was counted.
6. Standard: "Led to standardization" or "On-going discussion on standardization" was counted.
7. Start-up firm: The number of "Yes" to the query "Led to start-up firm establishment?" was counted.
8. <*> represents the items in which output or impact ratio in projects with a highly cited paper is 1.3 times or higher than the other projects.

Source: Survey of joint research team of Institute of Innovation Research, Hitotsubashi University and the National Institute of Science and Technology Policy, Survey on Knowledge Creation Process in Science

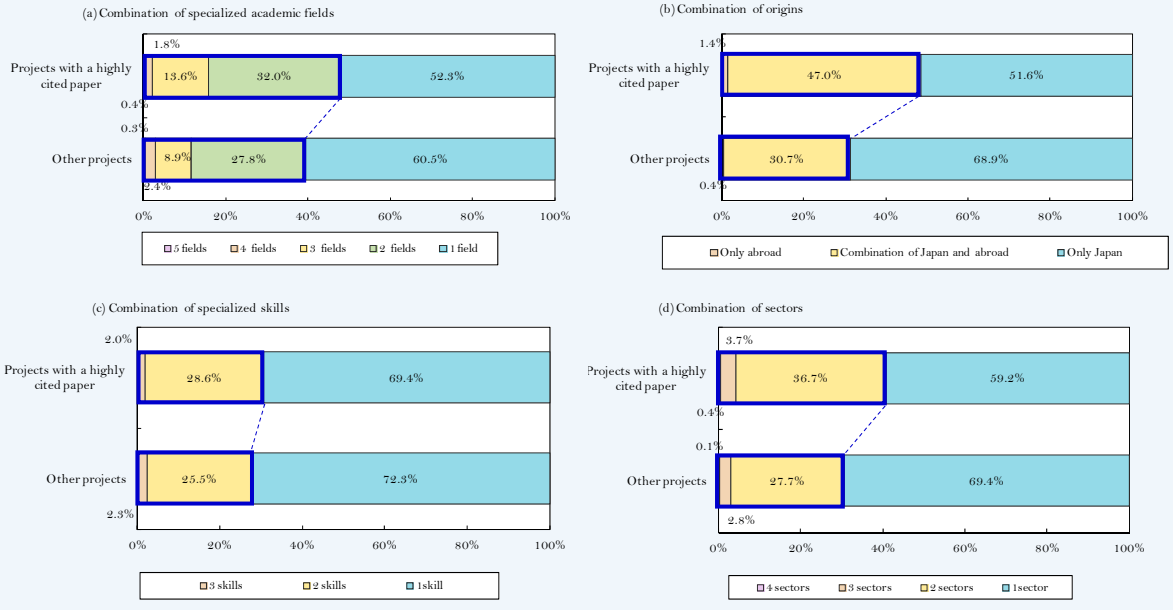
Figure 1-1-24/Profiles of the First Authors of the Research Papers



Note: 1. The analysis focuses on those papers the authors of which are ordered according to the contribution of the authors to the research.
2. Projects with a highly cited paper: research projects that produced one or more top 1% highly cited papers.
Other projects: research projects that produced ordinary papers (not among the top 1%).
3. If the research paper surveyed was written by six people or more, each of them was asked about his or her profile, and if the number of authors was seven or more, the first author, the last author, and the corresponding author were extracted by priority while the remaining coauthors would be randomly selected and asked.

Source: Joint research team of Institute of Innovation Research, Hitotsubashi University and the National Institute of Science and Technology Policy, Survey on Knowledge Creation Process in Science

Figure 1-1-25/ Diversity in Human Resources in the Research Teams



Note: 1. Same as Note 2 and Note 3 of Figure 1-1-24.
2. For the author's academic fields of specialization, each of them selects one from the 27 academic fields including mathematics, computer science, and chemistry. For specialized skills, each author selects one of the three categories of theory, experiment, and clinic. As for the affiliating sector, each author chooses from among university and the other higher education institutions, public research institutions, private firms, private non-profit research institutions, and others.

Source: Survey of joint research team of Institute of Innovation Research, Hitotsubashi University and the National Institute of Science and Technology Policy, Survey on Knowledge Creation Process in Science

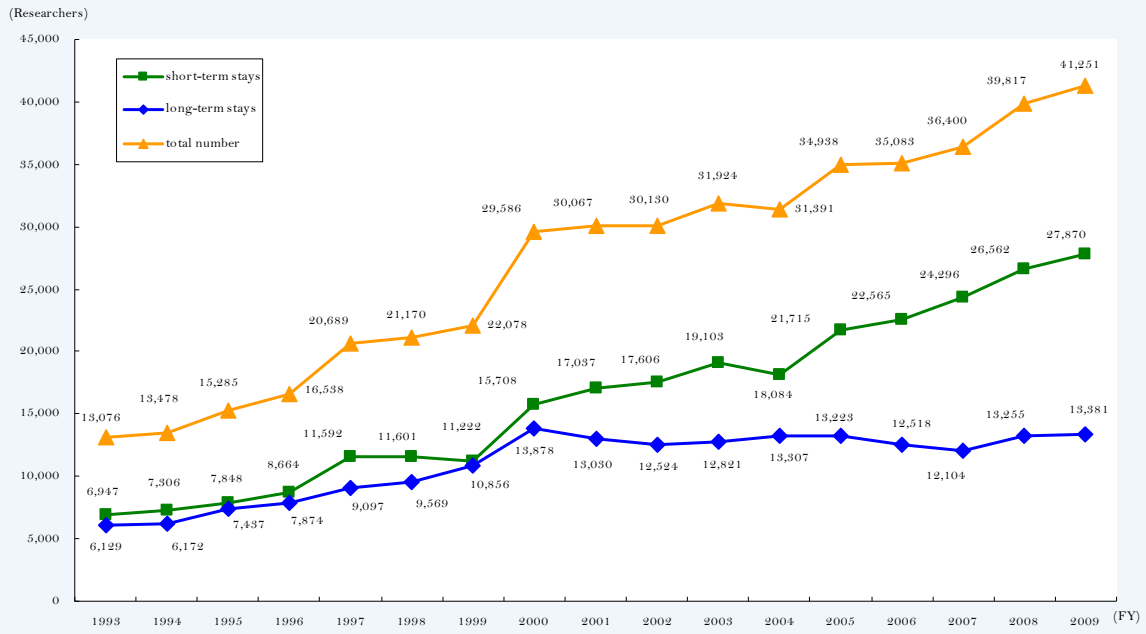
(2) Issues Surrounding Young Researchers in Japan

1) International Mobility

As competition for talents heat up around the world, it is important for young researchers in Japan to have the chance to interact with top researchers around the world and improve their skills. Therefore, it is crucial to improve the international mobility of the young researchers and to have a more flexible hierarchy.

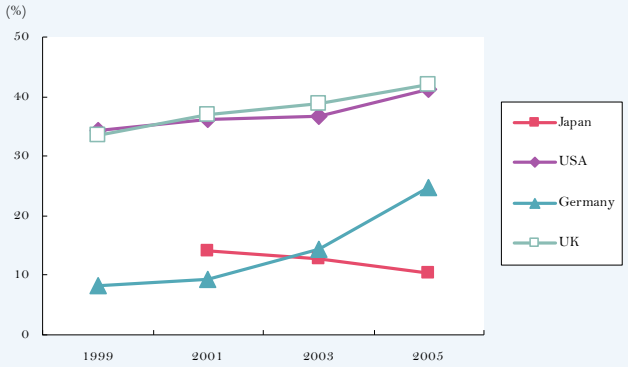
Looking at the current status of international mobility, the number of foreign researchers accepted in research institutions such as universities for long-term stays of more than 30 days is sluggish, though the total number of foreign researchers is on an upward trend. (Figure 1-1-26). In addition, the percentage of foreign doctoral students studying in science and engineering fields in Japan is extremely low, with only 10% compared to the high of 40% or more for the USA and U.K. (Figure 1-1-27).

Figure 1-1-26/Transition of Number of Foreign Researchers by Duration of Stay (Short-term, long-term)



Note: "Long-term" refers to a period of more than 30 days and "short-term" refers to a period of less than 30 days.
Source: MEXT, "Survey on International Research Exchanges"

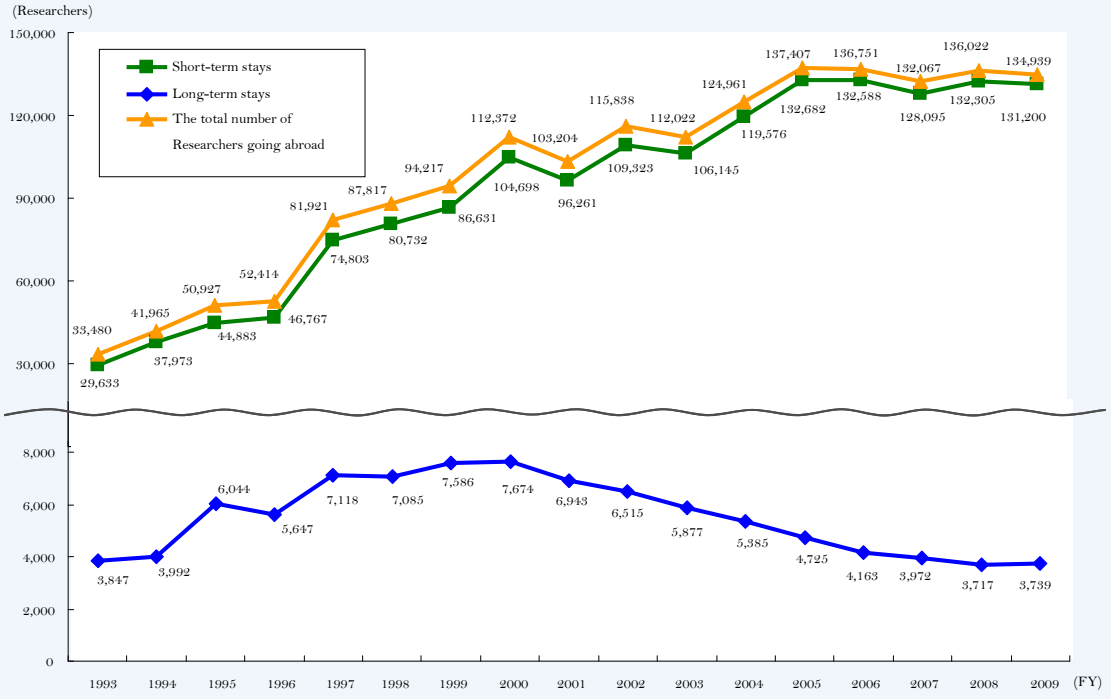
Figure 1-1-27/Transition of Percentage of Foreign Doctoral Students in Major Countries (Science and Engineering Fields)



Source: Created by MEXT based on NSF "Science and Engineering Indicators"

In terms of researchers sent abroad, the trend of long-term stays of more than 30 days is not only sluggish but also decreasing in recent years (Figure 1-1-28). Furthermore, only 2% of Japanese researchers leave to work abroad immediately after getting their PhD[1].

Figure 1-1-28/Transition of Researchers Working Abroad by Duration of Stay (Short-term, long-term)



Source: MEXT, "Survey on International Research Exchanges"

As for Japanese students studying abroad, the number increased significantly from approximately 15,000 around 1985 to a peak of 82,945 in 2004, but dropped again in recent years to less than 70,000, standing at

1 National Institute of Science and Technology Policy, "Analysis on the International Mobility of Doctoral Graduates in Japan" (March 2010)

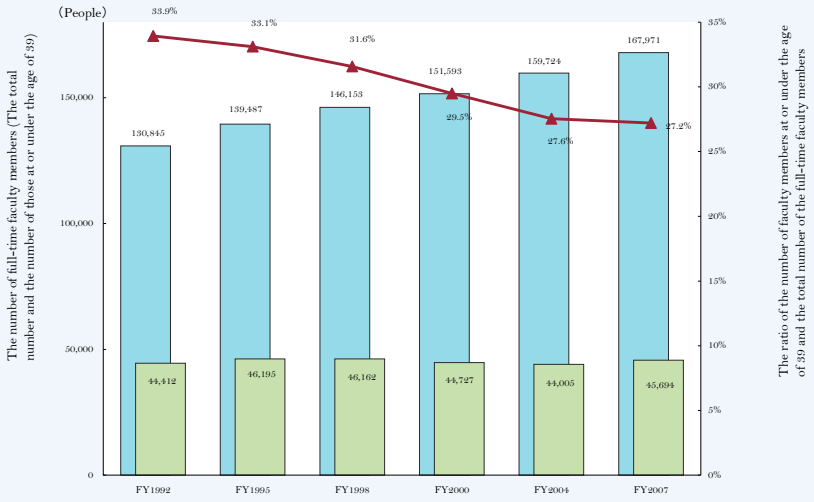
66,833 in 2008. In particular, the number of students going to universities in USA fell (2009: 24,842) to about half of the peak period (1997: 47,073), to around the same level as 1988 (24,000).

2) Young Researchers in Research Institutions such as Universities

In order to develop talented young researchers who can contribute globally, it is important to increase the number of posts for young researchers so that they have the opportunities to work independently, to demonstrate their abilities, and to understand their career path. In recent years, however, the percentage of young researchers in research institutions such as universities has been decreasing (Figure 1-1-29). Furthermore, according to an analysis of career paths for researchers conducted by the National Institute of Science and Technology Policy, the percentage of researchers born in the 1970s who have experienced non-termed employment in their 30s is lower compared to researchers born in the 1950s or 1960s regardless of the fields of specialization, suggesting that the system contractual employment for young researchers is gaining ground (Figure 1-1-30).

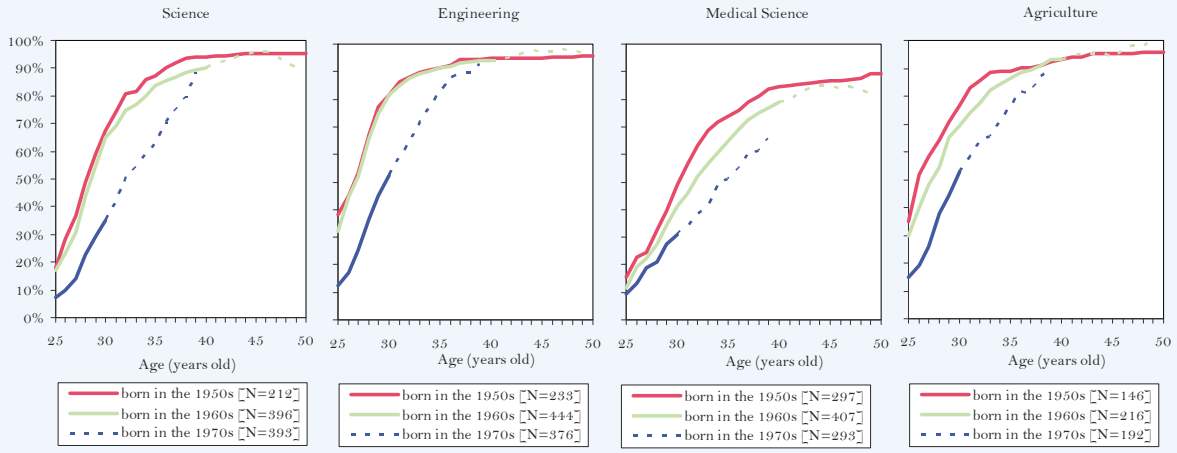
In this way, while it is true that this system allows young researchers to gain experience in different research environments and improve their networking as researchers, it is also pointed out that it dampens their enthusiasm. As universities gradually face a period of drastic generation change, it is timely to make use of this opportunity to increase the posts for young researchers.

Figure 1-1-29/Posts for Young Researchers in Universities



Source: Created based on "Survey on Staff Statistics" by MEXT

Figure 1-1-30/Percentage of Researchers who Have Experienced Non-termed Employment According to Generations (Categorized by Specialty)



Note: The N in the legend corresponds to the number of responses on the line. The dotted line only shows responses gathered are only for people who reached the ages shown in the horizontal axis as of end Dec 2009 and are derived from responses less than N.

Source: National Institute of Science and Technology Policy. "Independence Process of Researchers in Japanese – Large-scale Survey of Job History and Authority for Research" (March 2011)

(3) Efforts to Promote International Contributions of Young Researchers

In recent years, intellectual production activities have globalized and the number of internationally co-authored articles has been increasing worldwide, but compared to other major countries, Japan still lags far behind. Both Professor Suzuki and Professor Negishi, winners of the 2010 Nobel Prize for Chemistry, have pointed out the importance of overseas experience to provide opportunities to work with talented researchers from other countries and improve their skills, but based on the data above, it is hard not to conclude that young researchers nowadays still harbor a strong feeling of "looking inward". In addition, there is also a problem of the low acceptance of researchers into Japan and the overall issue of attracting talents to Japan.

In the National Institute of Science and Technology Policy's "A survey about mobility of researchers and diversity of research organizations (March 2009)," the percentage of researchers with overseas working experience who interact with other countries after their return is higher than those with no overseas working experience. This shows the importance of young researchers having overseas working experience as graduate students or postdoctoral fellows in order to build up a long-term overseas network.

On the other hand, according to the "Expert Survey on Japanese S&T System and S&T Activities by Fields (TEITEN Survey 2008)", it is found that one of the reasons why young researchers do not work or study in universities and research institutions overseas is because they worry about securing jobs when they return to Japan.

Therefore, in the 2010 budget, MEXT has newly established a "Strategic Young Researcher Overseas Visits Program for Accelerating Brain Circulation[1]" program in order to provide opportunities for young

1 Refers to many sophisticated talents moving across national borders to circulate. The policy is expected to encourage Japanese researchers to gain experience abroad and come back as global level researchers to contribute to the Japanese research activities.

researchers to train overseas while retaining their positions in domestic institutions. Furthermore, it has also expanded the "Postdoctoral Fellowship for Research Abroad" to provide opportunities for talented young researchers to focus on research based on their own research plan overseas on a long-term (2 years) basis.

In order to attract top-level researchers from around the world and produce world-class research, it is important to provide a "space" for talented researchers to develop. Therefore, MEXT is promoting the "World Premier International Research Center Initiative (WPI)" program and maintaining and improving the infrastructure for conducting the most advanced research in the world.

It is hoped that through implementation of these policies, young researchers' feeling of "inward thinking" will change to "outward thinking," and that we can develop talented young researchers who will become the core of international research networks in the international circulation of talents.

(4) Development and Retention of S&T Talents at Respective Levels

Not only is it important to develop creative young researchers who can contribute actively to future research activities and doctoral talents who can cut across the industrial, academic and administrative fields to lead the world in growth industries, it is also important to educate students in better environments to foster their scientific ability corresponding to their educational stages in universities and graduate schools, as well as elementary through senior high schools.

For this purpose, MEXT is implementing policies under its FY 2011 budget to develop and retain S&T talents at respective levels, such as strengthening the support to young researchers, strengthening the human resource development at universities and graduate schools, and widening the perspectives of children who like science and mathematics (Figure 1-1-31).

In elementary and secondary education, MEXT is strengthening the "Support for Super Science High Schools" which supports the latest science and mathematics education efforts in high schools, and has also established the "Science Koshien" to provide a platform for high school students who like science to learn from each other.

In higher education, based on the situation that there are not many doctoral talents who contribute to industries as compared to major countries such as USA, it is promoting the development of talents who will lead the world through the implementation of the "Leading Program in Doctoral Education", thus enabling industries to cooperate with academic institutions in order to develop talents who can communicate between the two fields and improve mutual understanding.

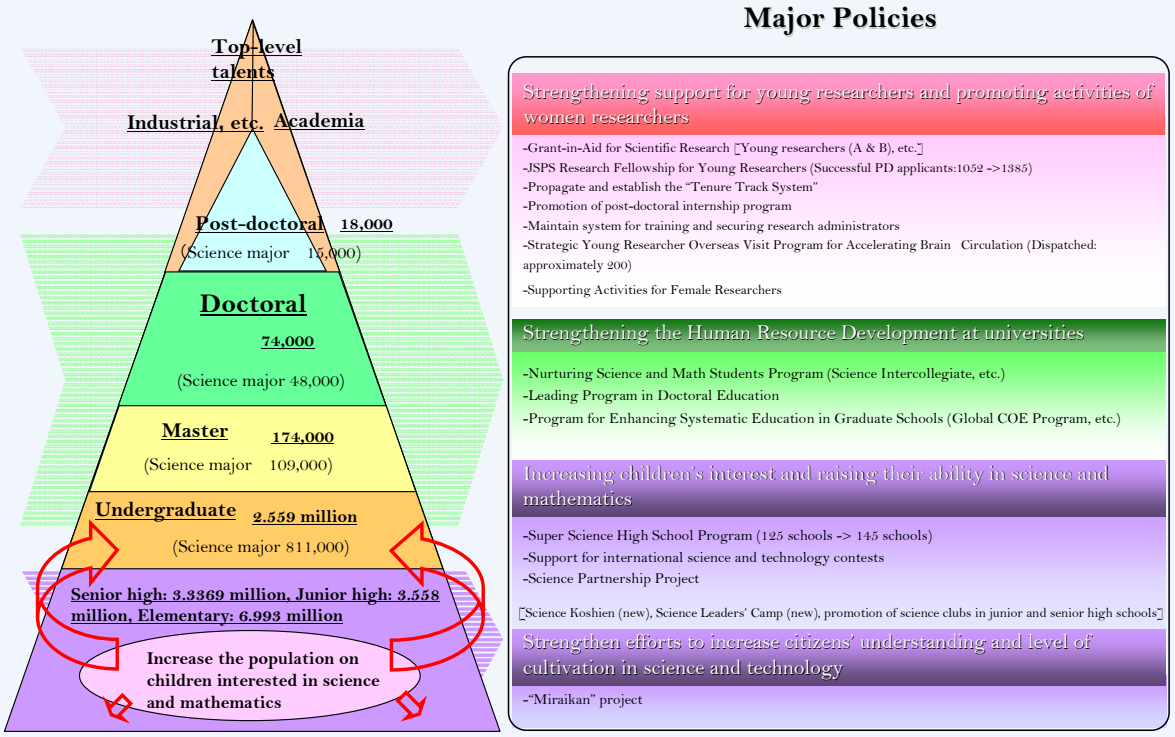
Furthermore, in order to focus on supporting young researchers, MEXT is also increasing the Grant-in-Aid for Scientific Research for young researchers, and allowing research funds to be used over a few years under the basic funding policy. In addition, it is also expanding the "JSPS Research Fellowship for Young Researchers" to provide scholarships to talented researchers so that they can focus on their research, and to propagate and establish the "Tenure Track System[1]" for young researchers to acquire assistant professorship after securing an independent research environment for some time and passing a screening.

In addition, based on the situation that there are too few female researchers in Japan compared to other

1 The system offers young researchers with opportunities to accumulate experience in an independent research environment on a fixed-term employment basis after going through fair and highly transparent selection process, and eventually get more stable positions after going through examinations.

countries, MEXT is also promoting the "Supporting Activities for Female Researchers," a program which supports research institutions such as universities with a support system such as research assistants for female researchers who juggle between work and family.

Figure 1-1-31/Development and Retention of S&T Talents at Respective Levels



Source: Created by MEXT

[Column 3] Increase Female Science Majors!

In Japan, very few women are interested in S&T in general[1]. While the number of female researchers has been growing in recent years, the percentage (13.6%) is still very low compared to developed countries in the West. Similarly while the percentage of females studying in science and engineering faculties and graduate schools has been growing recently, it is still less than 30%.

The appointment of female researchers is important not only from the point of view of equal employment opportunities for both men and women, but is also important to the organization because of the different perspectives and ideas they can bring to research activities and develop its creativity.

Therefore, the Cabinet Office is providing information via its website for female high school students and college students to have a clear image about their future and choose an appropriate education and career path for themselves under the theme "Challenge Campaign – Choice of Science and Engineering Fields for Female High School Students and College Students". In addition, the Japan Science and Technology Agency supports various efforts at universities and technical junior colleges to encourage female high school students to be interested in science subjects and choose them as their choice of study.

Universities are also doing their best to attract female science students. For example, in Tohoku University, female science graduate students called "Science Angels" organize various seminars and events, and conduct science lessons at high schools to convey to female high school students and university students why they think science is interesting. To female high school students, seeing such role models up close will no doubt affect what they choose to do in the future.

1 In the "Public Opinion Poll on S&T and Society (January 2010)" conducted by the Cabinet Office, the percentage of women who responded positively to the question "Are you interested in news or topics related to science and technology?" was 54.1%, low than 73.5% for men.

7 Participation of Researchers in Humanities and Social Science Fields

To promote science, technology and innovation, it is important to incorporate views of humanities and social sciences. The participation of researchers in humanities and social sciences become more important as they are expected to fulfill the following four roles.

1) Discovering and establishing social issues

2) Implementing research and development achievements in society (practical application)

3) Responding to Ethical, Legal and Social Issues (ELSI) regarding research and development

4) Formulating an appropriate S&T governance

In order to create innovation that creates economic and social value, it is important for the society system as a whole to understand how to link research achievements to innovation and promote research and development.

For this purpose, aside from reinforcement of the systems such as legal and taxation systems for promoting innovation, handling of intellectual property, and management of technology, it is important for researchers from the humanities and social science fields to engage in design and implementation of research plans and application of the research achievements to society. Those researchers need to take part in the activities from the initial stage of listing expected "social issues" from the economic and social standpoint in order to make the research achievements socially and ethically acceptable in society.

Furthermore, the participation of researchers from the humanities and social science fields is extremely important from the point of communication between researchers, technicians and society. Many policies have been carried out to promote communication with society and its participation in S&T activities, but they lack experience and are not structured. While Japan can study the efforts in the West, it is important for the Japanese government to define communication between society and researchers and technicians and to develop its own method of communication so that the process of communication can lead to consensus.

To this end, the Central Council for Education in its report "Graduate School Education for a Globalized Society – For Graduates to Contribute in Diverse Fields Worldwide" (January 31, 2011), pointed out that "with the systemic reforms caused by accelerated developments in S&T, inter-disciplinary and integration of academic fields, and in order to achieve the high-level targets involving nature, human, and society, such as the environment, life, information, it is important to develop talents that can see things with a bird's-eye view based on a wide array of knowledge". Therefore, promotion of cooperative research with trans-disciplinal approach is expected.

An example of researchers and technicians in the natural science and researchers in the humanities and social science working together to accomplish their target is the efforts by the Institute of Gerontology, The University of Tokyo. In order to tackle the wide-rang and complex issues surrounding super aging society, humanities and social science researchers in the fields of law, economics, sociology, psychology and education, and natural science researchers in the fields of medicine, nursing, science and engineering work on research projects together. It is crucial to promote such self-directed and active cooperation among researchers in the future.