Column 1-8

Efforts for Supporting Women's Active Roles in the STEM Disciplines in the USA.

"If we're going to out-innovate and out-educate the rest of the world, then we have to open doors to everyone. We need all hands on deck. And that means clearing hurdles for women and girls as they navigate careers in science, technology, engineering and math (i.e., STEM)." (Remarks by First Lady Michelle Obama on September 26, 2011)

The USA deems it necessary to develop excellent human resources in the STEM disciplines in order to out-innovate other countries. For this purpose, participation by female and diverse scientists in these disciplines is imperative. The USA also places value on policies supporting the increase of female scientists who play active roles in STEM disciplines, from the viewpoint of the advancement of women as well as of the enhancement of the national capacity in S&T. According to *Women in STEM: A Gender Gap to Innovation*, a report released by the U.S. Department of Commerce in August 2011, women with STEM jobs earned 33% more than comparable women in non-STEM jobs.

Efforts for encouraging female researchers to play more active roles are introduced below.

In November 2009, the U.S. Government announced the *Educate to Innovate* campaign, which is committed to improving STEM education. This campaign was created out of a concern over a decline in student achievement in STEM in the USA. One of the current focuses of this campaign is on the broadening of participation in STEM to all Americans, including women and girls and minorities. For example, in 2011, the U.S. Department of Energy introduced a new mentoring program to pair female undergraduate STEM students in the Washington, D.C., area with female employees who specialize in those subject areas. The program also encourages participating undergraduate students a new mentoring program to pair female undergraduate STEM students in the Washington, D.C., area elementary school students.

The White House Council on Women and Girls and the White House Office of Science and Technology Policy launched the Women in STEM Speakers Bureau in 2011, by which top STEM specialists are sent to communities for taking about their experiences to girls in grades 6-12.

On September 26, 2011, the White House Council on Women and Girls, the White House Office of Science and Technology Policy, and the National Science Foundation announced *NSF Career-Life Balance Initiative*, a 10-year plan to provide greater work-related flexibility to women and men in research careers. This plan aims to increase the share of women in the tenure-track faculty in STEM fields to 41%, the same share of women earning PhD's in STEM fields in 2009, by 2021.

To ensure that female researchers can take family care leave and can return to work after the leave, the following measures are taken.

- Allowing postponement of grants for parental leave – Grant recipients can defer their awards for up to 1 year to care for their family members.
- Providing supplements to cover research technicians – Principal investigators can apply for stipends to pay research technicians or equivalent staff to maintain labs while principal investigators are on family leave.

2 Improvement of Research Environments for Young Researchers

The creation of value and knowledge for advancing science, technology and innovation, which is necessary to solve diverse issues faced by Japan, is made possible by maximizing the potential of young scientists who can think flexibly and deliver results energetically.

Because S&T researchers around the world are building close-knit communities, it is important to foster Japanese human resources who can communicate with diverse international researchers, play active roles at home and abroad on the basis of a global viewpoint and provide leadership for international activities.

However, as noted in Chapter 1, satisfactory research environments are not in place in Japan for encouraging young researchers to fulfill their potential autonomously. Additionally, the international mobility of Japanese young researchers has remained low, resulting in a situation in which Japanese research institutions are mostly outside the network of international research institutions.

In the *Basic Policy to Drastically Strengthen R&D Capacity in Japan* decided by the Council for Science and

Technology (CST) in April 2013, concern was expressed about the current situation, and a proposal was made regarding the need to appoint young researchers as autonomous research leaders so that they will be motivated to play more active roles.

Based on the recognition mentioned above, young researchers, who are expected to build the foundation of future research, are analyzed below in terms of their current situation at universities and other institutions. Then, the analysis results are used for summarizing the issues that discourage young researchers from becoming independent, showing some of the ongoing efforts and identifying the future direction of efforts needed. Trends in the international mobility of researchers are also analyzed, and strategies for fostering the development of researchers capable of thinking and acting globally are suggested.

(1) Encouraging young researchers to autonomously and actively play roles

1) Importance of young researchers in scientific research

A report compiled by NISTEP in November 2013 shows the results of an analysis that focused on young researchers as a share of first authors for papers published by research teams. The purpose was to identify the contributions of young researchers to research projects.

In this report, young researchers as a share of first authors is greater than young researchers as a share of all authors, as indicated by the red arrows in Figure 1-2-37. Young researchers as a share of first authors and as a share of all authors are greater in the USA than in Japan, as indicated by orange arrows. In Japan, postdocs account for 20.5% of first authors for the top 1% most-cited papers[1] (i.e., papers drawing a great deal of attention) and 9.5% of first authors for other papers; those percentages for the USA are 28.4% and 19.4%. In both the USA and Japan, postdocs account for a higher share of first authors for the top 1% most-cited papers than for other papers, as indicated by blue arrows (Figure 1-2-37).

In the same report, the time lag between the publication of a paper and the citation of that paper by a researcher ("citation time lag") is regarded as an indicator of the pace of progress for that researcher's research, and the indicator is used for identifying how participation by young researchers in research projects affects the progress of those projects[2].

There is a correlation between citation time lag and estimated likelihood of postdoc participation (Figure 1-2-38). A shorter time lag means that the relevant papers are more recently published, and these are correlated with a higher likelihood of participation by postdocs.

This result suggests that postdocs and other young researchers are more likely to take part in leading-edge research projects, such as those that progress at a fast pace or attract a great deal of interest, and that these young researchers are making significant contributions to scientific research.

1 These are papers ranking in the top 1% of most cited papers worldwide.

2 A focus is put on the factors that determine the extent to which young researchers participate in research projects and on the contribution of these researchers to the research projects. On the assumption that postdocs have the most advanced knowledge and techniques necessary for research, the report started with the hypothesis that faster-progressing research projects are more likely to be those in which postdocs participate. The hypothesis was tested by estimating the likelihood of postdoc participation by logistic regression analysis.

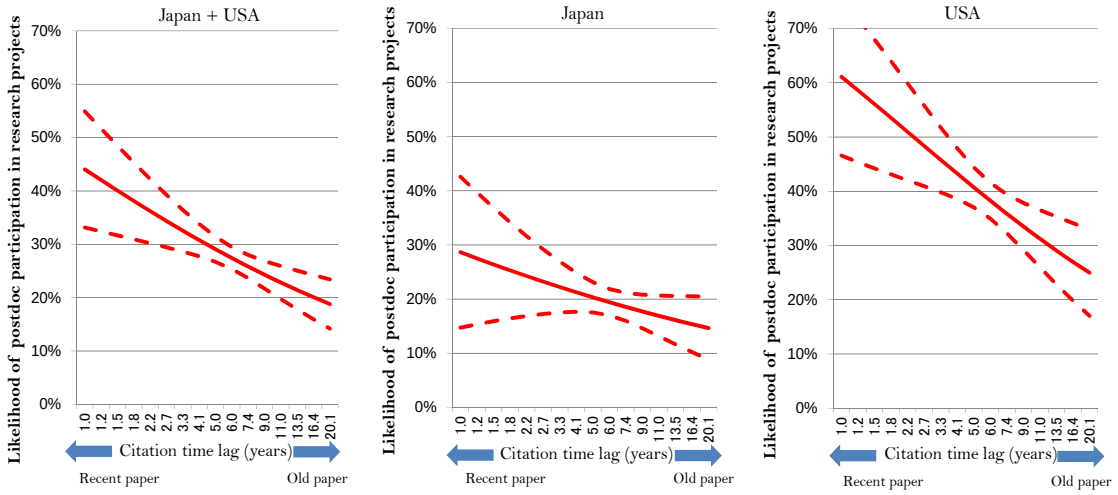
Figure 1-2-37 / Young Researchers as a Share of All Authors and First Authors

			Japan		USA	
			Papers	Top 1% papers	Papers	Top 1% papers
All authors (natural science)	Papers subject to survey		1,075	384	897	475
	Young researchers		26.6%	26.6%	33.0%	34.3%
		Students	20.2%	15.3%	19.4%	16.7%
		Posdocs	6.4%	11.3%	13.5%	17.6%
First authors (natural science)	Papers subject to survey		819	268	572	257
	Young researchers		35.8%	39.6%	51.2%	51.4%
		Students	26.3%	19.0%	31.8%	23.0%
		Posdocs	9.5% →	20.5%	19.4% →	28.4%

Note: The analysis was conducted on papers written by two or more authors. Data on first authorship were collected only from papers that show the authorship of researchers in their order of contributions.

Source: *Participations and Contributions of Young Scholars in Scientific Research – Evidence from the Hitotsubashi-NISTEP-Georgia Tech Scientists Survey in Japan and the US –*, Discussion Paper No. 103, NISTEP, November 2013

Figure 1-2-38 / Relationship Between the Likelihood of Postdoc Participation in Research Projects and the Citation Time Lag



Note: Solid lines show estimated figures, and dashed lines show 95% confidence intervals.

Source: *Participations and Contributions of Young Scholars in Scientific Research – Evidence from the Hitotsubashi-NISTEP-Georgia Tech Scientists Survey in Japan and the US –*, Discussion Paper No. 103, NISTEP, November 2013

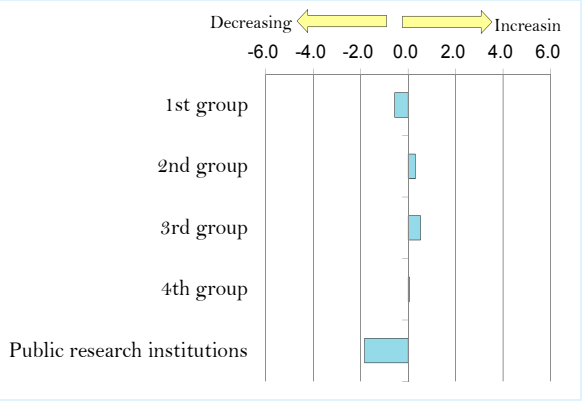
2) Autonomy of young researchers

Part I, Chapter 1, Section 2 (1) suggested that the traditional hierarchical research system at universities and public research institutions keeps young researchers from fulfilling their potential (see: Figure 1-1-11). Factors that have caused this situation are identified below from an analysis of researchers' recognition of the current situation.

(i) Young and mid-career researchers conducting independent research

The *NISTEP TEITEN Survey 2013* compared the number of young and mid-career researchers conducting independent research (i.e., researchers in their late 20s, 30s and 40s) with that number in 2005 (Figure 1-2-39). The comparison indicates that researchers at public research institutions and universities in the first group, a group of universities that are relatively more active in research than are other universities, are more aware of the decrease in the number of young and mid-career researchers conducting independent research than are researchers at other universities.

Figure 1-2-39 / Researchers' Awareness of Changes in the Number of Young and Mid-career Researchers Conducting Independent Research (in comparison with the number for 2005; by university group)



Note 1. Universities are divided into the following four groups according to their papers' share of all scientific papers published in Japan from 2005 through 2007. 1st group of universities: 5% or greater; 2nd group: 1% ~ less than 5%; 3rd group: 0.5% ~ less than 1%; 4th group: 0.05% ~ less than 0.5%

Note 2. Ratings on a 5-point scale (i.e., qualitative evaluation) were quantified and converted to index numbers for comparison. On this scale, ratings of 1, 2, 3, 4 or 5 respectively mean that the respondent thinks the number of young and mid-career researchers conducting independent research has "significantly decreased", "decreased", "remained unchanged", "increased" or "significantly increased". Each rating is converted to -10, -5, 0, 5 or 10, respectively. The number of valid respondents is multiplied by each point value (i.e., 1, 2, 3, 4, or 5), the five products are added and the sum is divided by the number of valid respondents.

Source: *Expert Survey on Japanese S&T System and S&T Activities by Fields (NISTEP TEITEN Survey 2013)*, NISTEP Report No. 157, NISTEP, April, 2014

(ii) Obstacles to autonomous research

The *NISTEP TEITEN Survey 2013* also identified why young and mid-career researchers are kept from conducting independent research (Figure 1-2-40).

The biggest reason is that researchers say they cannot work on research topics of their own because they are required to produce results in a short time. The second and the third biggest reasons are "It's difficult to advance independent research because stable sources of funding are unavailable" and "It's impossible to try to focus on original research topics under unstable employment conditions" (the red circle in Figure 1-2-40). With regard to the researchers at public research institutions alone, the second biggest reason is that they cannot decide their research topics at their discretion, because they are employed under fixed-term contracts for specific large research projects (the blue circle in Figure 1-2-40).

According to the survey results broken down by age, many researchers 49 years of age or younger feel that they cannot determine their research topics freely because the direction of research is decided by the laboratories they belong to or by their supervisors (the green circle in Figure 1-2-40).

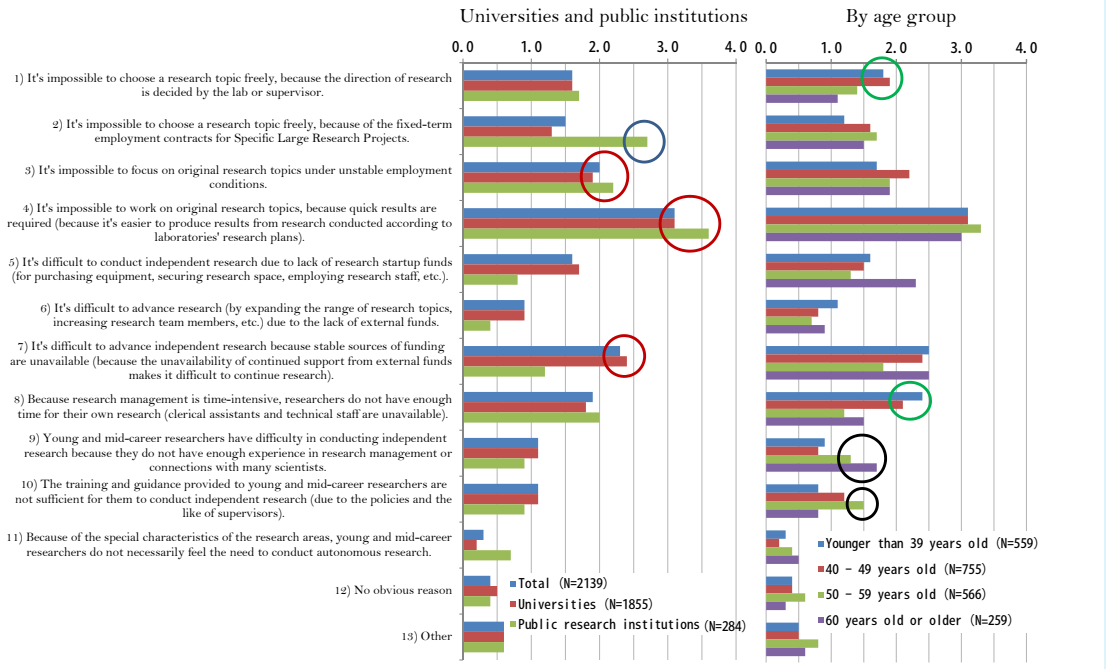
These responses indicate that many young and mid-career researchers are likely to face difficulties in conducting independent research by using their original ideas and techniques because they are hired for

specific large research projects under short-term employment contracts or because they engage in research for projects with predetermined research topics or in accordance with the research topics and protocols determined by their supervisors.

Researchers 49 years of age or younger also say that they are heavily burdened with the task of research management and, thus, cannot set aside enough time for their own research (the green circle in Figure 1-2-40). To the open-response question in the same survey, some respondents wrote as follows: "Increasing the number of clerical assistants and technical staff is imperative", "Young teaching staff and researchers at universities are enslaved by desk work irrelevant to research, so they can't concentrate on teaching and research" and "At universities, the time available to researchers for research is less than half the time available to researchers at private companies". These views show that young researchers need time to give their full attention to research.

In comparison to young researchers, researchers 50 years of age or older tend to choose "Training and guidance provided to young and mid-career researchers are not sufficient for them to conduct independent research" and "Young and mid-career researchers have difficulty in conducting independent research because they don't have enough experience in research management and connections with many scientists" (the black circles in Figure 1-2-40).

Figure 1-2-40 / Obstacles to Autonomous Research by Young and Mid-career Researchers



Note: Respondents were asked to choose the 1st, 2nd and 3rd biggest reasons from among 13 reasons. The weightings that determine the relative importance of the 1st, 2nd and 3rd biggest reasons are 30/3, 20/3 and 10/3. By using these weightings, the significance of each reason was converted to an index number. For example, if all respondents choose a certain reason as the biggest one, that reason is given an index number of 10.

Source: MEXT based on *Expert Survey on Japanese S&T System and S&T Activities by Fields (NISTEP TEITEN Survey 2013)*, NISTEP Report No. 157, NISTEP, April, 2014

Thus, the principal obstacles to autonomous research by young researchers are summarized as follows.

- Constraints on autonomous research due to the employment status of young researchers
- Lack of time and guidance necessary for young researchers to conduct independent research

3) Current situation regarding the employment of young researchers by universities and public research institutions

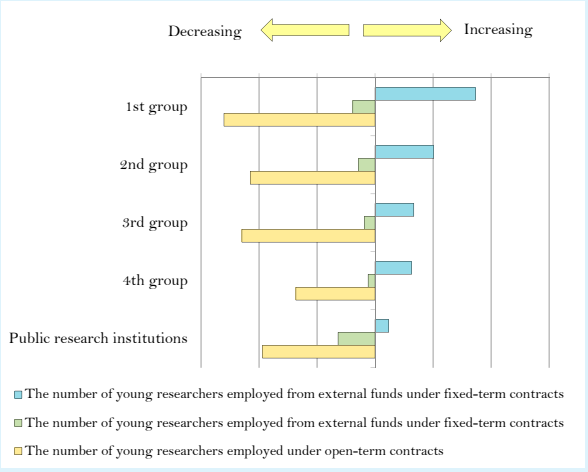
The NISTEP TEITEN Survey 2013 suggested that constraints imposed by employment systems of universities and institutions are the major factor that discourages young researchers from becoming independent. In view of this, an overview of the employment situation is given below regarding young researchers at universities and public research institutions.

(i) Employment status of young researchers

The *NISTEP TEITEN Survey 2013* looked at how universities and public research institutions perceive the changes in the number of young researchers from 2005 in relation to the following three employment systems: 1) employment under fixed-term contracts and using external funds, 2) employment under fixed-term contracts and using internal funds and 3) employment under open-term contracts.

A relatively large number of universities and public research institutions are aware that the number of young researchers employed under fixed-term contracts with external funds has been increasing, and that the number of young researchers employed under open-term contracts has been decreasing. This awareness is stronger in the first group of universities, which are assumed to have many external funding bodies (Figure 1-2-41).

Figure 1-2-41 / Universities' Perception of Changes in the Number of Young Researchers (in comparison with the number in 2005; by university group)



Note 1. Young researchers include postdocs, assistant professors and associate professors 39 years of age or younger. Students are excluded.

Note 2. Ratings on a 5-point scale (i.e., qualitative evaluation) were quantified and converted to index numbers for comparison. On this scale, ratings of 1, 2, 3, 4 or 5 respectively mean that the respondent thinks the number of young and mid-career researchers conducting independent research has "significantly decreased", "decreased", "remained unchanged", "increased" or "significantly increased". Each rating is converted to -10, -5, 0, 5 or 10, respectively. The number of valid respondents is multiplied by each point value (i.e., 1, 2, 3, 4, or 5), the five products are added and the sum is divided by the number of valid respondents.

Source: Expert Survey on Japanese S&T System and S&T Activities by Fields (NISTEP TEITEN Survey 2013), NISTEP Report No. 157, NISTEP, April, 2014

(ii) Financial sources for young researchers: basic compensation and project funds

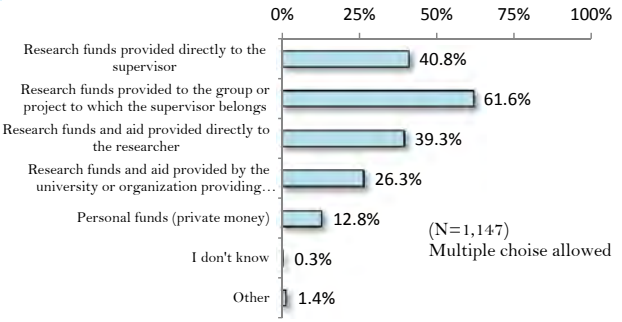
As the number of young researchers employed under fixed-term contracts has been increasing, the Science Council of Japan formulated recommendations in September 2011 titled *The Current Situation and Issues Regarding Postdocs as Well as Assistant Professors and Associates in Life Sciences Who are Appointed under Fixed-term Contracts*. A questionnaire survey of young researchers was conducted toward preparing the recommendations. According to answers to the question about basic compensation and project funds in a questionnaire that allowed multiple answers, 40% of the respondents reported being funded by research

funding secured by their supervisors, and 60% reported being funded by research projects in which their supervisors take part. Although nearly 40% of the respondents obtain funding for research on their own, young researchers predominantly depend on research funding provided by their supervisors or research teams in which their supervisors participate (Figure 1-2-42a).

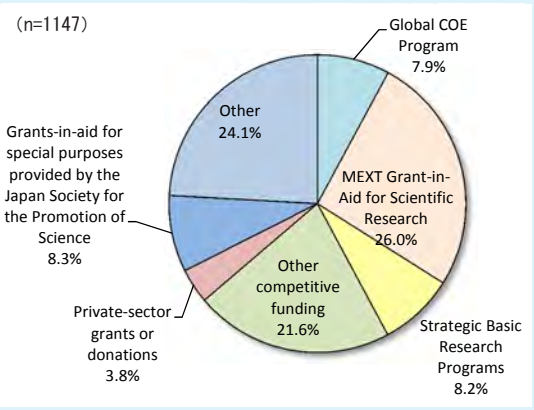
The funding for salaries is broken down into Grants-in-Aid for Scientific Research (26%), JST Strategic Basic Research Programs (8%), Global CEO Program (8%) and other competitive funding (22%). It is apparent that salaries for young researchers employed under fixed-term contracts are mostly paid out of external funding (Figure 1-2-42b).

Figure 1-2-42 /Major Sources of Funding for Research Expenses (Including Travel Costs) and for Salaries

a. Sources of Funding for Research Expenses (Including Travel Costs)



b. Sources of Funding for Salaries

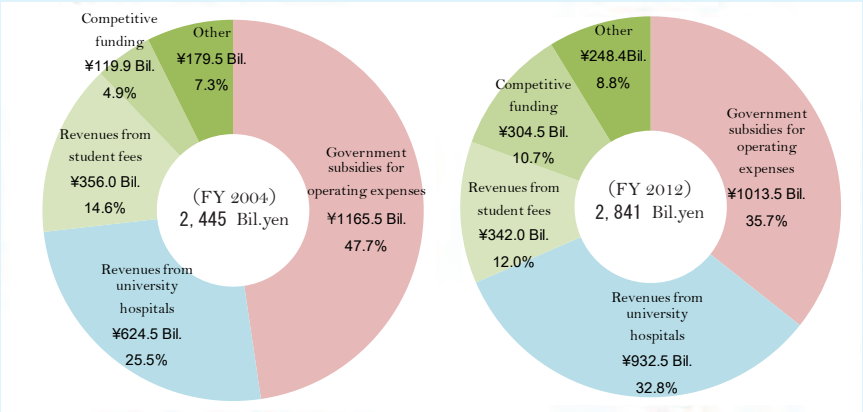


Source: *The Current Situation and Issues Regarding Postdocs as Well as Assistant Professors and Associates in Life Sciences Who are Appointed under Fixed-term Contracts*, recommendations from the Committee on Basic Medicine, the Science Council of Japan, September 29, 2011

(iii) Financial standing of universities

Comparison of the ordinary revenue in the financial statements of national university corporations between FY2004 and FY2012 indicates that government subsidies for operating expenses decreased while revenues from competitive funding increased in that period (Figure 1-2-43). This change in the financial situation of universities is the factor behind the rise in the number of young researchers employed by using external funds.

Figure 1-2-43/ Changes in the Breakdown of Ordinary Revenue at 90 National University Corporations



Note: Revenues from student fees are the sum of tuition, matriculation and entrance examination fees.
Competitive funding refers to the sum of revenues from commissioned research and projects, research-related revenues, subsidies and miscellaneous income (i.e., receipts related to subsidies and research).
Other revenues are the sum of revenues from contributions, revenues accruing from facilities expenses, financial revenues, miscellaneous income (excluding receipts related to subsidies and research), reversal of assets offsetting liabilities and other.
Source: MEXT

4) Learning of research skills and ethics by young researchers

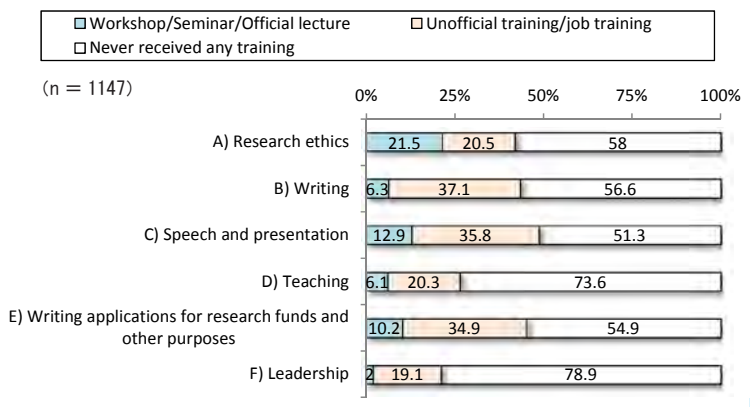
(i) Research skills

As noted in Part I, Chapter 1, Section 3 (1), the recent increase in the number of contributing authors per scientific paper indicates that research is increasingly conducted by teams instead of individuals. Thus, the composition and management of research teams have become major matters of concern. In view of this, young researchers are required to learn diverse skills, including teaching and management skills, in addition to basic skills necessary for writing and presentation.

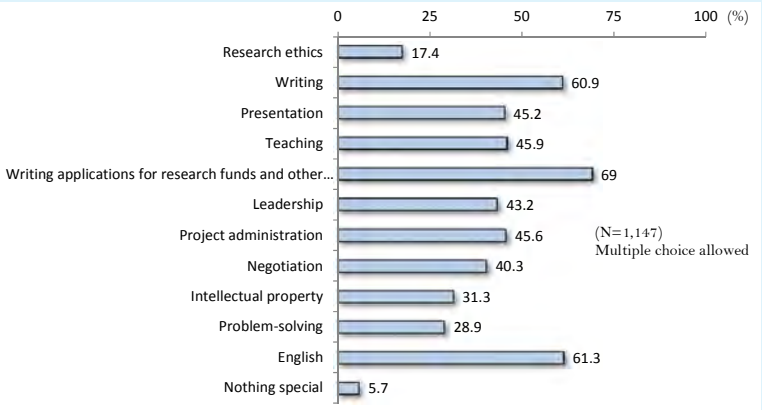
However, a questionnaire survey of young researchers employed under fixed-term contracts shows that these researchers are not provided with sufficient training for learning diverse research skills. Researchers who have received official or unofficial skills training account for only 26.4% of all researchers regarding teaching skills and 21.1% of all researchers regarding team management skills (Figure 1-2-44a). In contrast, nearly half of the respondents reported wishing to have training in teaching skills (45.9%), research team management skills (43.2%) and project management skills (45.6%). These data suggest that young researchers' needs are not being sufficiently met (Figure 1-2-44b).

Figure 1-2-44 / Learning of Research Skills, and the Like

a. Things researchers have learned while holding their current position



b. Things researchers wish to learn through official training



Source: *The Current Situation and Issues Regarding Postdocs as Well as Assistant Professors and Associates in Life Sciences Who are Appointed under Fixed-term Contracts*, recommendations from the Committee on Basic Medicine, the Science Council of Japan, September 29, 2011

(ii) Research ethics

Fewer than half of the respondents say they have learned research ethics while holding their current position, although research ethics are vitally important for researchers. Adequate guidance on research ethics is not given to young researchers (Figure 1-2-44a). Additionally, the share of respondents who wish to have training on research ethics (17.4%) is very small (Figure 1-2-44b).

Against the backdrop of recent scientific misconduct, the Molecular Biology Society of Japan conducted a questionnaire survey[1] regarding research ethics and misconduct in 2013. It found that 47.3% of the responding assistant professors and associates and 45.5% of the responding postdocs agreed with the need for education toward reducing the incidence of research misconduct[2].

The survey results shown in Figure 1-2-44 are as of 2011, and young researchers have been increasingly aware of the need for training in research ethics year after year. However, because the level of awareness is not high enough, it is necessary to provide thorough guidance to a broad range of people involved with

1 *Summary of the 36th Annual Questionnaire Survey*, The Molecular Biology Society of Japan, August 28, 2013 (http://www.mbsj.jp/admins/ethics_and_edu/enq2013.html)

2 Although the survey was given only to members of the Molecular Biology Society of Japan, the results seem to speak of the reality of researchers, because this academic society represents many Japanese scientists working at the forefront of research in life sciences.

research activities, including students and young researchers at universities and research institutions.

5) Future efforts for encouraging young researchers to become independent

The survey results above confirm that many postdocs and other young researchers in Japan take part in project teams working on leading-edge research, and that the likelihood of young researchers' participation is positively correlated with superior research performance (i.e., likelihood of producing highly cited papers). These results suggest that young researchers are playing an irreplaceable role in scientific research as great contributors to science.

However, it is difficult for many of these researchers to conduct research autonomously, because they are employed with the research funding secured by their supervisors or the research projects of their supervisors, and such external research funding can be used only for limited purposes. Furthermore, the inadequacy of guidance and support given to young researchers so as to enable them to conduct independent research seems to have resulted in the current situation where young researchers are unable to apply themselves to autonomous research.

To ameliorate the situation, young researchers should be fostered according to their development or career stages, and research environments need to be improved.

Currently, universities and public research institutions have diverse understandings of the roles and responsibilities of young researchers. They do not share a common understanding of the need for, and adequacy of, guidance, training and advice for young researchers as well as of the need to create adequate environments for autonomous research by young researchers. This situation raises a concern about the possibility that little progress has been made to provide adequate support to young researchers.

In this connection, researchers' career paths need to be defined and specified according to the development stages of researchers, and research environments should be improved for each stage of the researcher's career. Efforts that should be made in the future to that end are described below.

(i) Clear definition of career paths

In the USA[1], career paths for Ph.D. faculty are classified into the three stages of postdoc, tenure-track teaching position (i.e., job that can lead to a tenured position) and tenured position. Postdocs are in the training stage, tenure-track positions correspond to the trial stage in which researchers are evaluated on their ability to conduct independent research and to hold tenured positions, and tenured positions correspond to the stage in which researchers conduct research autonomously.

In Europe[2], researchers have four career stages, from R1 to R4, as follows: R1: First Stage Researcher (up to the point of Ph.D.); R2: Recognized Researcher (Ph.D. holder or equivalent who is not yet fully independent); R3: Established Researcher (researcher who has developed a level of independence); and R4: Leading Researcher (researcher who leads the research area or field).

By using these classifications for reference, the career paths of Ph.D. holders are largely divided into the three stages of postdoc, newly established young researcher ("young principal investigator") and principal investigator.

1 NIH website (http://grants.nih.gov/training/careerdevelopmentawards.htm)
2 European Commission, *Toward a European Framework for Research Carriers*" (Brussels, 21st July 2011)

Postdocs who have only just earned their Ph.D. are in a stage prior to establishing themselves as independent researchers. They are given proper guidance and training by supervisors, they engage in research actively and they learn the research ethics and skills that are necessary for becoming independent.

Young principal investigators are in the early stage of principal investigator. They are given appropriate advice by experienced researchers, and they advance their original research for a fixed period of time in research environments where they can work autonomously. They are assessed under a very fair evaluation program that determines whether they can be recognized as independent researchers. These young principal investigators are also required to learn skills for instructing students and postdocs before proceeding to the next career stage.

Principal investigators are in a stage following the stage of young principal investigator. They need research environments in which they can secure a genuinely autonomous research system for themselves and can play active roles in leading young researchers. Because they assume responsibilities for mentoring young researchers as well as for research activities, their contributions to guidance, training and advice for young researchers need to be properly evaluated as part of their research performance.

As described above, the autonomy of researchers should be used as a criterion for standardizing the definitions of career paths according to the researchers' development stages. Universities and research institutions are required to affirm a common recognition of the defined career stages in connection with the positions held by researchers. Based on the common recognition, universities and research institutions need to promptly improve research environments so that young researchers can conduct research autonomously according to their development stages, and they need to ensure the rapid development of programs for providing young researchers with guidance, training and advice in a systematic manner.

(ii) Improvement of research environments for postdocs

Because postdocs are in a stage prior to establishing themselves as independent researchers, they need to have proper guidance and training by supervisors, and they need to engage in research actively and learn the research ethics and skills that are necessary for becoming independent. Basically, they need to be responsible for writing scientific papers, and they need to go through on-the-job training in the use of budgets for the research projects they are involved with. Therefore, supervisors should foster the growth of postdocs as researchers; they are not allowed to use postdocs solely as a workforce that helps with research, although it is not a problem to employ postdocs by using budgets that are supposed to be spent for specific research projects and not for allowing postdocs to conduct research completely freely.

There have been cases of scientific misconduct by Japanese researchers in S&T research and development. These cases can erode the public's confidence in science and can undermine international trust in Japan's scientific community. The improvement and enhancement of researcher training and education in research ethics are strongly desired in order to prevent scientific misconduct.

Researchers in charge of providing guidance and training to postdocs are required to give them responsibilities for the preparation of scientific papers, letting them use their creative ideas for writing papers. These researchers should also assure adequate guidance in research skills and ethics to postdocs. Universities and research institutions need to strengthen governance toward ensuring that postdocs are provided with adequate training in research skills and ethics. Furthermore, the scientific community in Japan should examine and demonstrate the kinds of research skills and ethics that need to be learned by

researchers at various development stages and how they can learn these according to the characteristics of different fields of specialization.

Column 1-9

Skills Required of Postdocs in the USA

After completing a Ph.D., young American researchers aspiring to work at academic institutions usually follow a career path that takes them from postdoc positions to tenure-track positions and on to tenured positions. Postdoctoral positions (postdocs) in the USA are regarded as temporary positions at which postdoctoral scholars advance their careers before taking tenured positions. The National Science Foundation (NSF[1]) and the National Institutes of Health (NIH[2]) have defined "postdoctoral scholar" as an individual who has received a doctoral degree (or the equivalent) and is engaged in a temporary and defined period of mentored advanced training[3].

A postdoc first aims at taking a position as an assistant professor at a university other than the one where the scholar received the doctoral degree. Only after becoming an assistant professor is the scholar given a laboratory and the liberty to engage in research as an independent research faculty. Assistant professors, however, assume responsibilities for teaching, research performance and university administration in return for that liberty. Specifically, they are required to teach students and provide them with research guidance, to achieve research results of a certain academic level toward earning recognition from academic societies, to be able to acquire research grants and to provide service to the university and its committees. The ability to obtain grants is particularly important for continuing research. Grants are necessary immediately after one takes the position of assistant professor.

Applying for grants is an obligation of independent researchers, and success in acquiring research grants depends on the researcher's competency in writing grant applications. For example, an NIH grant applicant needs to fill out an application form consisting of 25 pages solely for the research protocol and many other pages for detailed descriptions of the aims and background of the intended research, the significance and meaning of the expected research results, pilot study results, the specific research schedule, potential pitfalls and alternative approaches, and the need for personnel expenses and equipment cost. Thus, some universities in the USA require graduate students, and not just postdocs, to fill out NSF grant application forms as a paper that graduate students need to turn in for qualifications screening, so that these students can develop and acquire the writing skills that they will need in the future as researchers[4]. Before being able to take a position as an assistant professor, the applicant has to undergo face-to-face interviews with multiple professors of the university to which the applicant is applying. Success in the interviews depends on the applicant's presentation skills. The applicant needs to carefully plan in advance how to explain the value and the potential of his/her work in ways understandable and convincing to interviewers who specialize in the same discipline as the applicant or in other disciplines. In short, conversation skills are among the many skills that are required in order for scholars to take positions as assistant professors. By experiencing job interviews, postdocs in the USA develop skills for effectively communicating the values and the potential of their research to interviewers.

In the USA, scholars are allowed to concurrently apply for multiple faculty positions, whether or not they are willing to take the positions; thus, it is possible to compare the conditions offered by several universities before seriously considering which position to take. An applicant who has received the offer of a position from more than one university inquires of these universities about their contract terms and starts negotiating with each of them by presenting the applicant's requirements as well as the contract conditions that the applicant has been offered by the other universities. Negotiation skills are also required of U.S. researchers, so that they are able to work under better conditions in terms of pay, teaching content and load, and research environment.

The conversation and negotiation skills that postdocs in the USA develop are necessary for them to establish themselves as researchers. Even when they fail to take tenured positions, these skills help them to pursue careers outside academia.

1 National Science Foundation
2 National Institutes of Health
3 "Postdoc" as defined by the NSF (http://www.nsf.gov/statistics/srvygradpostdoc/)
"Postdoc" as defined by the NIH (http://grants.nih.gov/training/q&a.htm#2491)
4 *Comparative Physiology and Biochemistry*, Vol. 18, No. 1, the Japanese Society for Comparative Physiology and Biochemistry

Postdocs who have adequate capabilities and experience as researchers need to further enhance their capabilities by using their "percent effort"[1] in whole or part for independent research, besides the research projects of other researchers. For this purpose, research fellowships should be made available to these postdocs. Additionally, it is necessary to make arrangements so that postdocs can independently acquire research funds and conduct research while engaging in research projects of principal investigators who employ these postdocs by using the budget for their research projects.

iii) Improvement of research environments for young researchers

a) Research environments necessary for young principal investigators

Young principal investigators who have just become independent are in the early stage of principal investigator. They are given appropriate advice by experienced researchers, and they pursue their original research during their term of contract in a research environment where they can work autonomously. A very fair evaluation program assesses them and determines whether they can be recognized as independent researchers.

As are postdocs, many of young principal investigators are employed with external funds. Particularly when they are employed under budgets for government research projects, they are obliged to engage in research only according to the research topics and the plans of the projects. This situation makes it difficult for young researchers to conduct unique research based on their original ideas. It is a matter of concern.

In light of this, universities and public research institutions need to give consideration to the career stages of young principal investigators and provide them with positions and research environments that match their career stages. One solution to the current problem of young principal investigators' positions is the introduction of a tenure-track program.

Because young principal investigators are in an early stage of establishing themselves as independent researchers, it is desirable that they be employed under the basic research funds of universities and research institutions as much as possible. As indicated in Section 1, it is important for universities and research institutions to consider the balance between the number of positions under fixed-term contracts and the number of positions under open-term contracts for both young researchers and senior researchers.

When young principal investigators are employed under external funds, it is desirable that the funds be provided at least without setting limitations on the investigators' freedom to conduct research autonomously. Institutional improvement is also necessary to allow young principal investigators employed for government-funded research projects to conduct independent research.

With the growing significance of external funds, young researchers' time has been increasingly occupied with miscellaneous tasks other than research. To remedy this situation, it is important to make arrangements for the use of research support personnel, including research administrators, and to increase flexibility in the use of research budgets.

The adequate allocation of indirect costs is also important. Currently, competitive research funds of the national government are not necessarily allocated to indirect costs, but indirect costs are indispensable for projects supported by competitive research funds. Through the adequate allocation of funds to indirect costs, basic research funds of universities and public research institutions can be more effectively used for

1 "Percent effort" means the time devoted to a particular research project as a share of the researcher's total work time.

employing young researchers and improving their research environments. A review of policies pertaining to this is desirable.

b) Program to Disseminate Tenure-track System

Universities and public research institutions that have a tenure-track program in place provide tenured positions to young researchers, after a rigorous screening process whose aim is to confirm that these young researchers are talented and qualified as independent researchers and that their research performance is outstanding. Before the screening, young researchers are given an opportunity to gain experience working as autonomous researchers, having discretion for a certain period of time.

Since FY2006, MEXT has been promoting the introduction of the tenure-track system as part of the *Program for the Improvement of Research Environments for Young Researchers* supported by the Special Coordination Funds for Promoting Science and Technology. MEXT aims at enhancing reforms of personnel systems and systems for fostering human resources at universities and research institutions and also at improving research environments for facilitating autonomous research by young principal investigators.

Various arrangements are made at universities and public research institutions that introduce tenure-track systems to ensure that young researchers in tenure-track positions can concentrate on their research by exploiting their abilities to the full. These arrangements include the creation of a startup environment so that tenure-track researchers can go ahead with their research without delay, the improvement of support programs and the maintenance of space for tenure-track researchers' research activities.

In a program for promoting the introduction of the tenure-track system, universities and institutions were selected and provided with support for research startup costs. This program was developed into the *Program to Disseminate Tenure-track System* in FY2011 for also selecting excellent tenure-track faculty members to provide them with research funds. Universities and institutions are urged to prepare research environments that facilitate autonomous research by these faculty members, and to develop support programs for ensuring adequate guidance and advice by supervisors and for unfailingly providing tenure-track faculty members with tenured positions.

The Program to Disseminate Tenure-track System has helped to develop fair and transparent systems of open recruitment and screening for tenure-track researchers, resulting in the reform of personnel systems at universities and institutions using the tenure-track system. But the tenure-track system has not disseminated enough to make it a system that is fully competitive internationally. The report *About the Progress and Improvement of Basic Measures and Other Measures Related to Basic Research and Human Resource Development*[1], published by the Council for Science and Technology Policy (CSTP) on November 22, 2012, makes the following recommendations: "Although the tenure-track system has been steadily disseminated, the number of universities and institutions that have adopted and are using the system has not increased

1 *About the Progress and Improvement of Basic Measures and Other Measures Related to Basic Research and Human Resource Development Implemented with S&T-related Budget FY2013*, the Minister of State for Science, Technology and Innovation Policy, and executive members of the Council for Science and Technology Policy (CSTP), November 22, 2012

enough to achieve the target[1] set for FY2015. The original purpose of the tenure-track system is to recruit and develop talented scientists. Through an exhaustive study of the current system for confirming whether it is serving that purpose, the tenure-track system should be refined to promote its dissemination."

Toward that target, the tenure-track system should be further disseminated and exchanges of young researchers should be promoted. At the same time, it is important for all parties concerned to cultivate a shared understanding of the career stages of young tenure-track principal investigators.

(iv) Revisions to the Guidelines for Evaluation

In April 2014, MEXT revised the *Guidelines for Evaluation of R&D in MEXT Proposal* for the purpose of developing effective systems for educating and mentoring young researchers, and specified "promoting the development of and support for future-generation researchers" as one of the important issues.

The revised guidelines include new approaches to the evaluation of R&D topics, R&D institutions and researcher performance. A particularly significant approach is the adoption of a new evaluation criterion that was formulated from the viewpoint of contributing to the development of, and support for, young researchers. Specifically, the evaluation of R&D topics is based on information provided by representatives of research projects in order to avoid burdening young researchers with the responsibility of preparing documents necessary for evaluation. R&D institutions are evaluated by assessing their environment and systems for providing research guidance to doctoral students, and by their measures for doctoral students' career development. Evaluation of R&D institutions is based not only on their research performance but also on various measures they take, including their efforts for improving research environments for young researchers, supporting young researchers and career stages of postdocs, and developing young researchers' career paths. Regarding the evaluation of researchers' performance, the revised guidelines introduced approaches for giving incentives to mentors of young researchers. For example, research performance is evaluated by developing an assessment method that encourages ambitious research activities by young researchers. The performance of faculty and researchers as mentors is evaluated from a broad perspective so that their guidance to postdocs and doctoral students and their efforts for career development are also taken into consideration.

It is desired that all parties concerned implement evaluations on the basis of the revised guidelines without undue delay, in order to promote the development of, and support for, young researchers in Japan.

1 In *the Fourth Science and Technology Basic Plan*, a target of 30% was set for tenure-track faculty as a share of newly employed young faculty members in life sciences at all universities in Japan.

Column 1-10

Career Development Awards for Young Researchers: K Awards

The National Institutes of Health (NIH), one of the world's foremost medical research centers, is an agency of the U.S. Department of Health and Human Services (HHS). This agency provides research grants[1] and supports the research of many researchers, ranging from graduate students to senior scholars, at universities and research institutions in the USA. The NIH has many grant programs for young researchers, including Fellowships and Training Grants (F&T Awards) for individuals with or earning a research doctorate and Career Development (K) Awards that provide support for young researchers holding full-time positions currently so that they can advance their research careers and reach the point where they are able to conduct their research independently.

K Awards are defined as Research Career Development Awards (RCDA) for fostering the development of young scientists, and they especially focus on support for young researchers at various career stages, including researchers who have just become independent after being mentored in research training, researchers who need advanced training before being able to engage in leading-edge research and mid-career researchers aiming to become research leaders[2]. A newly established award is K99/R00, a research grant program launched in 2006 for facilitating a transition by researchers from postdoctoral research positions to principal investigators. It is the only K Award that has no citizenship requirement for applicants. This award provides up to 5 years of support consisting of two phases. The initial phase will provide 2 years of mentored support for postdoctoral research scientists. This phase will be followed by up to 3 years of independent support contingent on the applicant securing an independent tenure-track position. Salaries for awardees are included in the award budgets. All these grants are awarded to young individuals with the aim of fostering the development of researchers and not of achieving specific research results. Because salaries that otherwise are paid by universities are paid out of the award budgets, awardees are absolved of their duties to teach and provide service to universities, on the condition that they have obtained other research grants at the time of grant application; thus, they can devote themselves to research. When young researchers are accepted as RCDA awardees, universities employing these researchers are required to state in a written application their assurance that the awardees are absolved of responsibilities for teaching and other service to the university. These universities use the funds that otherwise would be used for paying salaries to the grant awardees for the short-term employment of researchers who engage in teaching and service to universities in place of the awardees[3]. In the USA, where the principle of competition is respected and successful applications for research grants prove a researcher's ability to become independent, grants are carefully planned and provided to researchers who are at various development stages and on diverse career paths.

Furthermore, the eligibility criteria regarding applicants for NIH grants are reasonable, not based on applicant age but on years elapsed after one has obtained a doctorate or has become independent as a researcher. Thus, NIH grant opportunities are available to diverse human resources, such as re-enrolled adult graduate students and scholars specializing in various disciplines. Under the grant programs in the USA, researchers satisfying certain conditions can allocate direct costs to payroll costs, and some grant programs are flexible in that grant awardees are allowed to pay their own salaries out of the grants they have obtained[4].

Increasing the number of Research Career Development Award (RCDA) programs so as to provide young scientists with opportunities to apply for grants will be effective in fostering young researchers, because they will have good opportunities to clinically review their research topics and projects in the application process.

(2) Fostering scientists who play active roles globally

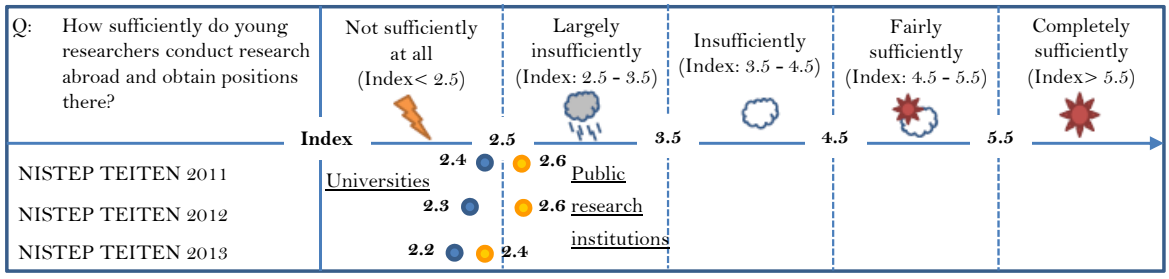
1) International mobility of researchers

As indicated in Part I, Chapter 1, Section 2 (2), the international mobility of Japanese researchers and students is low. The *NISTEP TEITEN Surveys* show that researchers at universities and public research

1 Research grants are subsidies or contributions provided by government agencies or private financial groups to support scientific research conducted by individuals, groups of researchers or organizations.
2 NIH website (http://grants.nih.gov/training/careerdevelopmentawards.htm)
3 *Comparative Physiology and Biochemistry*, Vol. 18, No .2, the Japanese Society for Comparative Physiology and Biochemistry
4 *Grants Awarded by the National Science Foundation (NSF)*, written by Takakuni Ikeda for a magazine published by the Center for National University Finance and Management, August 18, 2009

institutions consider the current situation to be significantly unsatisfactory in terms of the number of young researchers studying or working overseas, and that the situation has been getting worse with each passing year (Figure 1-2-45).

Figure 1-2-45 / Recognition of the Situation Regarding the Number of Young Researchers Studying or Working Overseas (Expert Survey Results)



Source: MEXT based on Expert Survey on Japanese S&T System and S&T Activities by Fields (NISTEP TEITEN Survey 2013), NISTEP Report No. 157, NISTEP, April, 2014

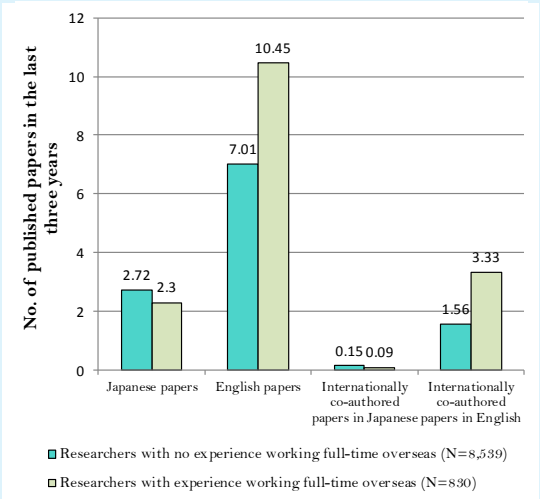
2) Positive results after engaging in research overseas

A NISTEP survey shows that scientists who have worked as full-time researchers overseas produce more papers in English than other scientists do. They produce more than twice as many internationally co-authored papers than scientists with no experience of working full-time overseas produce (Figure 1-2-46).

An analysis focusing on researchers' international mobility and its impact also indicates that the research productivity of researchers who have engaged in research internationally is higher than those who have been conducting research domestically (Figure 1-2-47).

More than 70% of the highly cited Japanese researchers who are engaging in research internationally at present have experience of working abroad. Many of them worked in other countries at the age of 35 or younger (Figure 1-2-48).

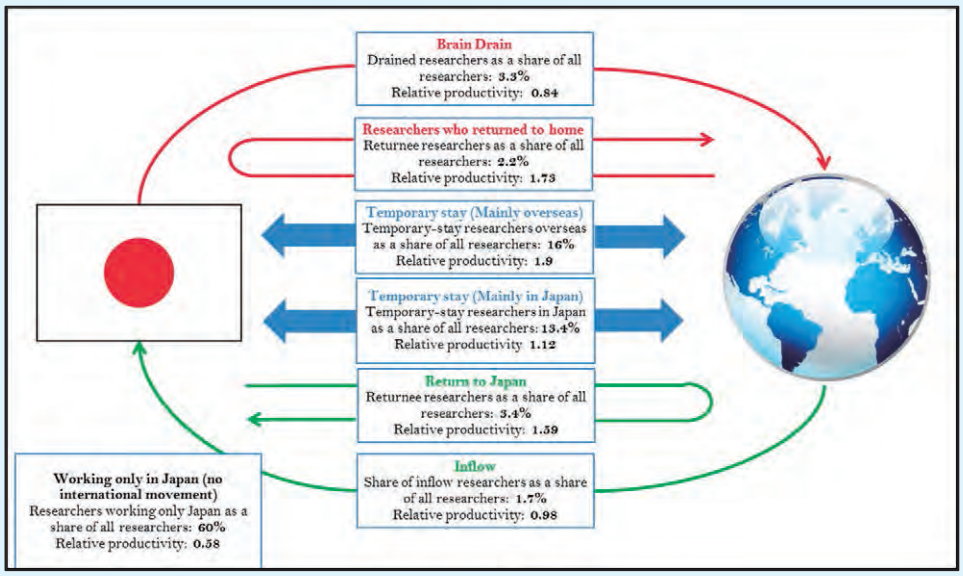
Figure 1-2-46 / Researchers with Experience of Working Full-time Overseas, and Number of Published Papers



Note: "Researchers with experience of working full-time" refer to researchers who have engaged full-time in research abroad.

Source: *A Survey about Mobility of Researchers and Diversity of Research Organizations*, NISTEP REPORT No. 123, NISTEP, March 2009

Figure 1-2-47 / Comparison of Research Productivity from the Viewpoint of Researcher Mobility



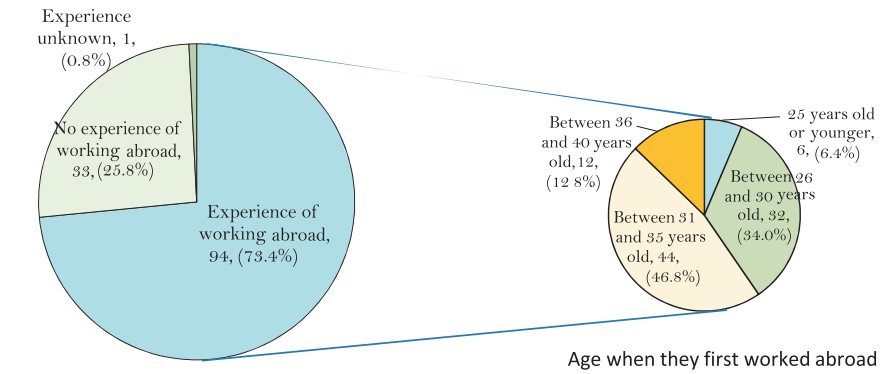
Note 1. This chart is based on the analysis of research productivity conducted by Elsevier Co. that used Scopus Author Profiles for collecting data on authors belonging to Japanese research institutions who published papers from 1996 through 2012. The analysis focused on researcher mobility between Japan and other countries.

Note 2. "Researchers who returned home" refers to those who stayed in other countries for 2 or more years. Staying overseas for less than 2 years is regarded as "temporary stay".

Note 3. "Relative productivity" means the ratio of annual average research productivity of a group of researchers from 1996 through 2012 to all Japanese researchers' research productivity which is defined as 1.

Source: MEXT based on data collected by Elsevier Co.

Figure 1-2-48 / Highly Cited Japanese Researchers' Experience of Working Abroad, and the Age at Which They Worked Abroad for the First Time



Note: "Highly cited researchers" mean authors of journal papers ranked in the top 250 in each of the 21 disciplines in the Thomson Reuters database.

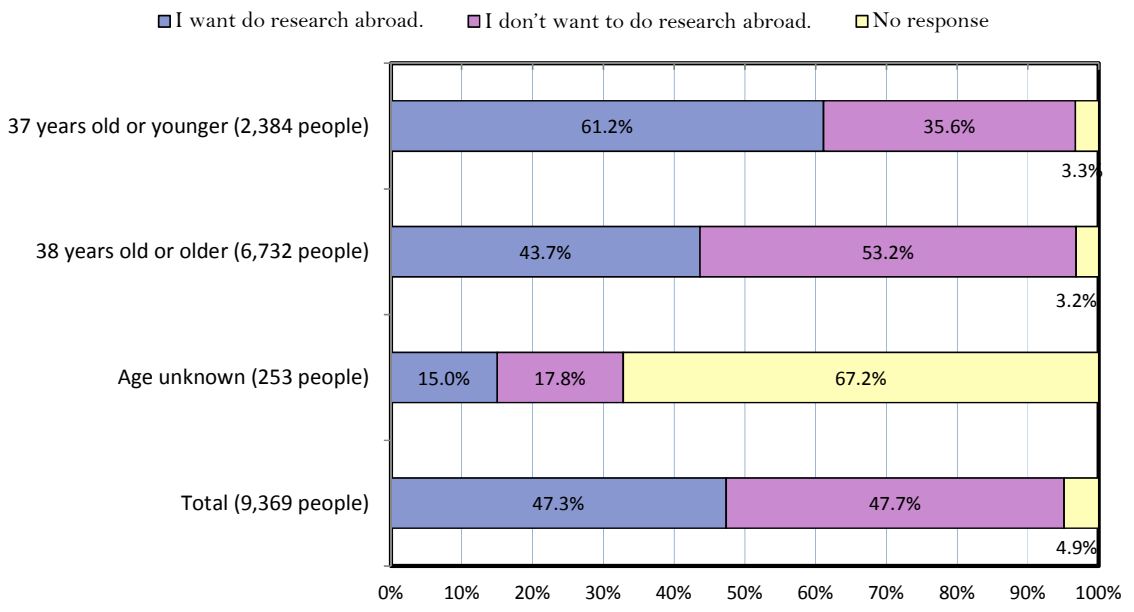
Source: *Analysis on Career Paths of the Most Highly Cited Scientists in Japan through International Comparison*, Discussion Paper No. 78, NISTEP, August 2011

Regarding the positive effects of working abroad on researchers, the International Committee of the Council for Science and Technology states in its report[1] that researchers working abroad are expected to 1) enhance their capacities by taking part in advanced research, 2) garner hands-on experience of international-standard research and researchers' communities and 3) develop an ability to play a pivotal role in international research networks.

3) Perceptions held by researchers

The experience of research overseas leads to positive results, as shown above, and there are researchers who are willing to engage in research outside Japan. According to a NISTEP survey, more than 60% of researchers 37 years of age or younger hope to conduct research abroad (Figure 1-2-49).

Figure 1-2-49 / Willingness of Researchers at Japanese Universities and Public Research Institutions Specializing in Natural Sciences to Work Overseas (FY2008)



Source: NISTEP based on *A Survey about Mobility of Researchers and Diversity of Research Organizations*, NISTEP Report No. 123, NISTEP, March 2009

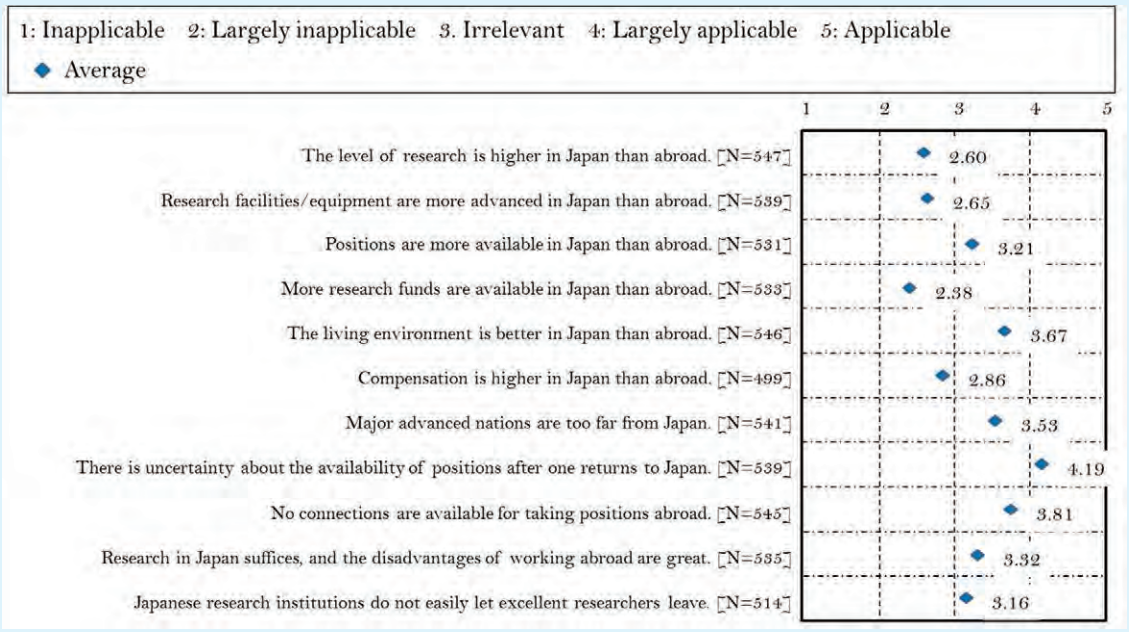
4) Reasons for low international mobility

Despite the fact that young researchers are willing to engage in research abroad, the number of researchers and students going abroad has not been substantially increasing, as indicated in Section 2-2, Chapter 1.

A NISTEP survey shows that the principal reason for the low international mobility of Japanese researchers is the uncertainty about the availability of positions after they return to Japan (Figure 1-2-50).

1 *Strategic Development of International S&T Activities Based on the 4th Science and Technology Basic Plan*, Council for Science and Technology (CST), January 2013

Figure 1-2-50 / Reasons for the Lower International Mobility of Japanese Researchers in Comparison with Researchers in Other Major Countries



Source: *Survey on Mobility of Science and Technology Researchers in Japan*, Survey Material 163, NISTEP, MEXT, January 2009

5) Efforts needed in the future

The analysis results above show that experience of working abroad positively affects young researchers, underscoring the importance of increasing the international mobility of Japanese researchers. To increase the opportunities for young researchers to develop by learning from other researchers abroad, it is necessary to launch international research projects and to financially assist young researchers in paying the costs of travel, staying in other countries, research and the like.

Because young researchers hesitate to work abroad despite their wish to work there, some measures are needed to secure positions for researchers returning to Japan. Additionally, undergraduate and graduate students should be encouraged to study abroad. According to a NISTEP survey[1], the share of Japanese doctoral graduates who take positions with foreign institutions is 10.1% for those who have experience of research activities abroad, whereas the share is 2.4% for doctoral graduates without experience abroad. Increasing the number of students studying abroad leads to a broader base of human resources who are able to provide leadership internationally and helps to develop a larger number of scientists who can assume positive roles in international research networks in the future.

6) Specific programs

(i) Support for sending young researchers overseas

As support to individual students, *JSPS Postdoctoral Fellowship for Research Abroad*, a support program of the Japan Society for the Promotion of Science, offers round-trip international airfare and maintenance

1 *Analysis on the International Mobility of Doctoral Graduates in Japan*, Survey Material 180, NISTEP, March 2010

allowances for covering the living and research costs of excellent young Japanese researchers, so that they can conduct long-term research on their own projects at overseas universities and research institutions. In FY2013, 441 researchers using this support program were sent to universities and research institutions in 22 countries and regions.

As support given to universities and research institutions, the Japan Society for the Promotion of Science started the JSPS Strategic Young Researcher Overseas Visits Program for Accelerating Brain Circulation in FY2011[1]. For the purpose of fostering the development of excellent researchers who can play pivotal roles in international research networks, support is provided to universities and institutions that send young researchers overseas in order to give them opportunities to take part in international-standard research at foreign research institutions. This support program is marked by the opportunity for researchers to gain research experience at foreign institutions while maintaining positions at the Japanese universities and institutions that send the researchers abroad. One of the main reasons why many researchers hesitate to work abroad is the uncertainty over the availability of positions after their return to Japan; thus, this support program helps to dispel that uncertainty. It can encourage young researchers to gain experience abroad, at least to some degree. In FY2012, 530 researchers using this support program were sent to universities and research institutions in 54 countries and regions.

(ii) Enhancement of study overseas

The Japan Revitalization Strategy: Japan is Back, a strategy approved by the Cabinet on June 14, 2013, provides that the number of Japanese students shall be doubled to reach 120,000 by 2020, with the aim of fostering human resources who have global perspectives and are internationally competitive. According to this strategy, opportunities to study abroad are provided to all talented young students who are highly motivated to study.

Based on the *Japan Revitalization Strategy*, a promotional campaign known as "*TOBITATE! Ryugaku Japan*" was launched to enhance opportunities for young students to study abroad. A public-private partnership program that helps students to study abroad was started with the aim of utilizing private funds as well as government funds to provide society-wide support for the fostering of qualities and abilities needed by society[2]. This program is expected to help researchers of the future to have high-quality academic experience and to join global research networks at a young age.

(iii) Efforts for the future

To increase the number of young researchers and students working or studying abroad, it is necessary to secure positions that they can take when they return to Japan. Although some measures have been taken in this regard, further efforts are desired, as mentioned in Section 1 of Chapter 2. Specifically, the mobility of Japanese researchers should be increased and more opportunities should be provided to young researchers so that they can apply for the positions that they deserve.

When universities and independent administrative institutions in Japan recruit researchers, they should ensure that employment information is also provided to young scientists working abroad. These

1 In FY2010, this support program was implemented under the name of the *Young Researcher Overseas Visits Program for Vitalizing Brain Circulation*.
2 In March 2014, *TOBITATE! Young Ambassador Program* (i.e., *Japan Public-Private Partnership Student Study Abroad Program*) started to accept applications from students.

universities and institutions need to develop systems for enabling young Japanese researchers overseas to apply for and take positions while staying abroad, and also for properly evaluating these researchers' research performance abroad in screening their applications. It is also important that young Japanese researchers abroad be given opportunities to inform universities and research institutions in Japan of their research performance. Other effective measures include the introduction of a system for giving priority to scientists who have experience abroad in employment, and the setting of targets in terms of researchers having experience abroad as a share of all researchers at universities and research institutions.

Furthermore, support for young Japanese researchers abroad so that they can take positions at foreign universities and research institutions will help to increase employment opportunities. Increasing the number of Japanese researchers working actively abroad is meaningful not only for securing positions for researchers but also for developing international research networks.

To advance these measures, the Japanese government is required to formulate measures for encouraging young researchers to work abroad, improving their working conditions and increasing the positions available to them in an integrated manner.

3 Improvement of Working Conditions for International Researchers

In the midst of globalization, problems that remain to be solved are increasingly complicated. International researchers, who have different cultural backgrounds, help to vitalize research in Japan, and their unique ideas and viewpoints contribute to the creation of knowledge that serves as the basis for innovation. Increasing the number of international researchers in Japan is also important for strengthening the worldwide network of researchers. Thus, to enhance the research capacity of Japan, it is necessary to employ international researchers more actively.

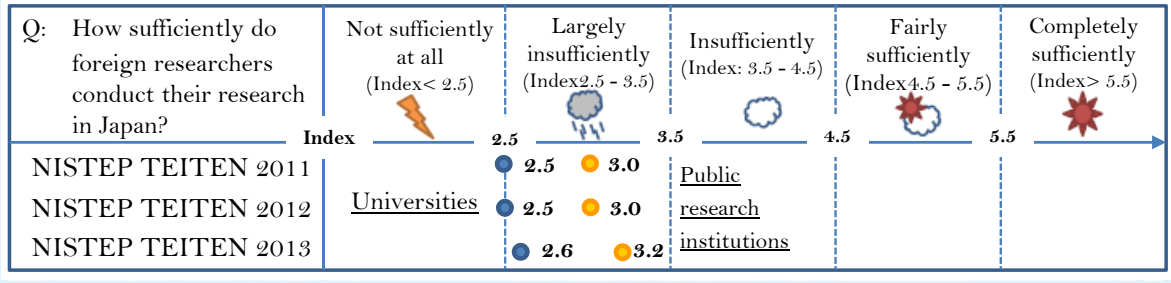
In light of the importance of international researchers, the current situation is analyzed in relation to the number of international researchers in Japan and their perception below. Issues to be solved, ongoing programs and future directions are also summarized.

(1) International researchers at universities and research institutions

1) International researchers at universities and research institutions

Recently, foreign nationals account for an increasing percentage of faculty members and researchers at universities and independent administrative institutions specializing in R&D. However, foreign nationals accounted for only a 4% share of researchers at universities and only an 8% share of researchers at independent administrative institutions on average in FY2013, which is much smaller than the 20% figure for universities in the USA. (Figure 1-1-43, Figure 1-1-44). The NISTEP TEITEN survey also shows that researchers at universities and public research institutions consider the number of international researchers in Japan to be insufficiently large (Figure 1-2-51).

Figure 1-2-51 / Recognition of the Situation Regarding the Number of International Researchers in Japan (Expert Survey Results)



Source: MEXT based on *Analytical Report for 2013 NISTEP Expert Survey on Japanese S&T and Innovation System (2013 NISTEP TEITEN survey)*, NISTEP, April, 2014

2) International students in Japan

Many of the international researchers in Japan first came to Japan as undergraduate or graduate students and have been in Japan ever since. According to a survey of international students and researchers at Japanese institutions (*Survey on the Perceptions Held by International Researchers*; the details of this survey are shown in Figure 1-2-52), 45.5% of the international researchers at the postdoc stage came to Japan as students, and they have continued to stay in Japan or have returned to Japan after engaging in research in other countries. Postdocs who came to Japan as students account for 55.9% of the postdocs from Asian countries. In view of this, increasing the number of international students at universities is important for increasing the number of excellent international researchers working in Japan. At the same time, it is necessary to attract students from more diverse countries and to enhance the quality of international students.

Figure 1-2-52 / Outline of the *Survey on the Perceptions Held by International Researchers*

In February 2014, MEXT conducted a survey via the Internet of the perceptions held by international researchers and students working or studying at 16 Japanese organizations. An outline and the attributes of the respondents are as follows.

Affiliations: 16 organizations (Hokkaido University, Tohoku University, University of Tsukuba, University of Tokyo, Tokyo Institute of Technology, Nagoya University, Kyoto University, Osaka University, Kyushu University, Keio University, Waseda University, Okinawa Institute of Science and Technology Graduate University, High Energy Accelerator Research Organization, RIKEN, National Institute for Materials Science, and AIST (Note: Respondents at universities are those specializing in science and engineering.)

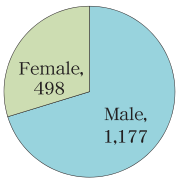
Valid responses: 1,675 (477 in Japanese and 1,198 in English)

Attributes of respondents

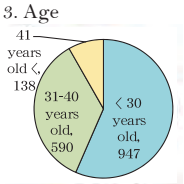
1. Profession

Researcher	593	Professor, associate professor, lecturer	94
		Assistant professor, research associate	145
		Postdoc	321
		Other (research staff, technician, or the like at independent administrative institutions)	33
Student	1,082	Doctoral student	986
		Other (Student in master's course, undergraduate student and the like.)	96

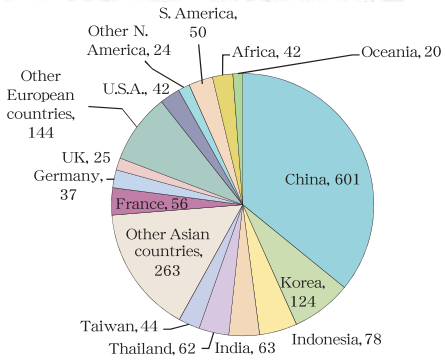
2. Gender



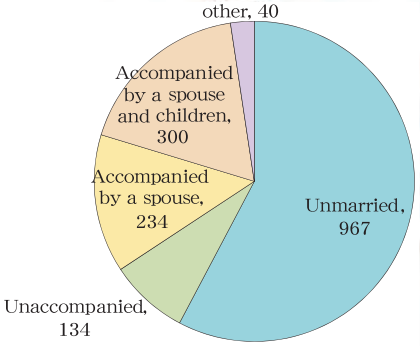
3. Age



4. National/regional origin

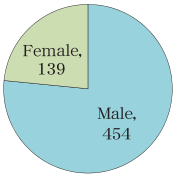


5. Accompanied by family

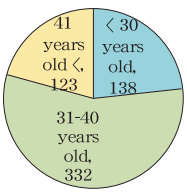


<Attributes of the 593 researchers>

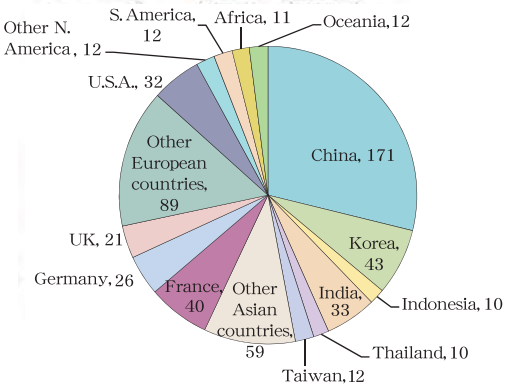
2. Gender



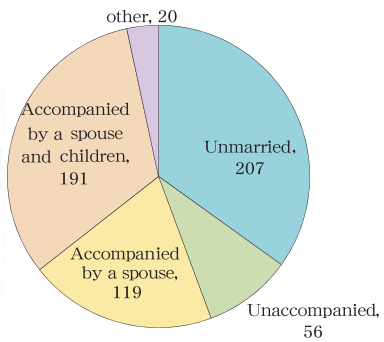
3. Age



4. National/regional origin



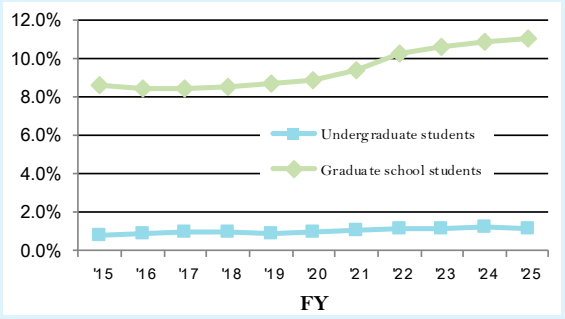
5. Accompanied by family



Note: Regarding "National/regional origin", countries and regions included in "Other Asian countries", "Other European countries", "Other North American countries", "South America", "Africa" and "Oceania" are unknown. Thus, Europe, for example, may include countries from which a larger number of researchers come in comparison with the number of researchers from France, Germany or the U.K. The same applies for Asia.

The *School Basic Survey* shows that, while foreign nationals as a share of all students majoring in science, engineering, agriculture or health science at Japanese universities has remained almost unchanged at 1% for undergraduates, the share for graduate students has gradually increased to 11.1% as of FY2013 (Figure 1-2-53).

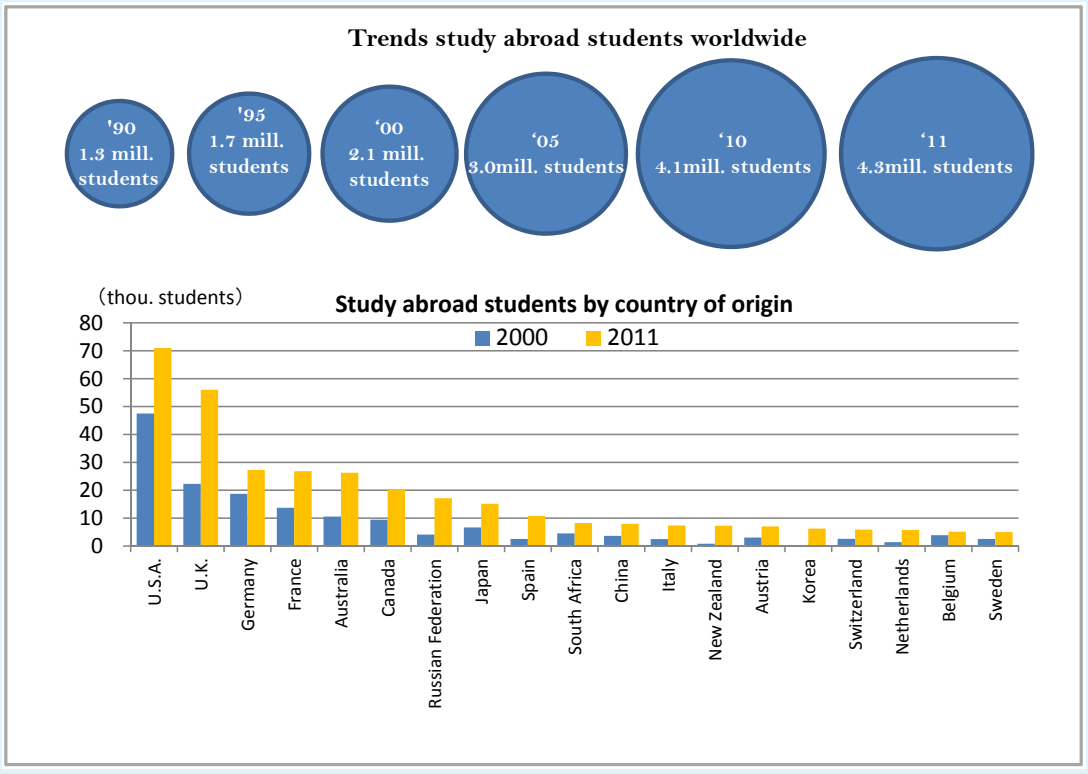
Figure 1-2-53 / Changes in International Students as a Share of All Students



Source: MEXT based on the *School Basic Survey*

An OECD survey shows that the number of international students enrolled at higher education institutions worldwide doubled in the 11 years from 2000 through 2011. In the same period, the number of international students at Japanese institutions of higher education increased by a factor of 2.2; thus, the increase rate in Japan is slightly higher than the global average increase rate (Figure 1-2-54).

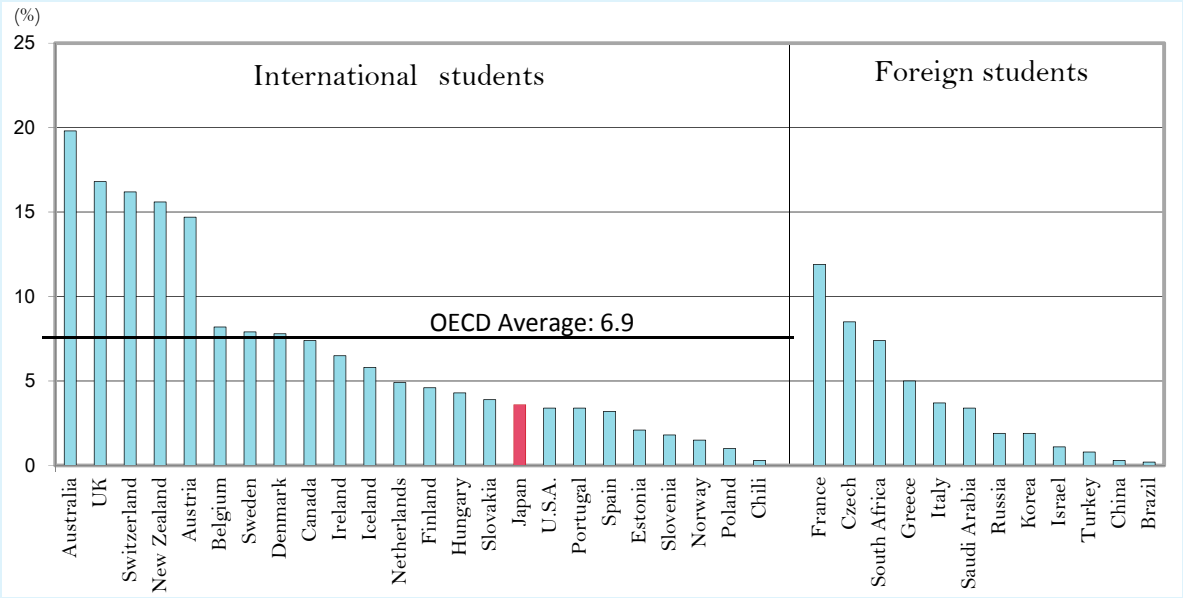
Figure 1-2-54 / Number of International Students at Higher Education Institutions, Broken Down by Country



Source: MEXT based on *Education at a Glance 2013*, OECD

However, international students as a share of enrollment at higher education institutions in Japan is smaller than the OECD average (Figure 1-2-55). Universities in Japan have been steadily increasing the number of enrollments of international students since the turn of the 21st century, but the increases have not been significant enough.

Figure 1-2-55 / International Students as a Share of Enrollment at Higher Education Institutions, Broken Down by Country



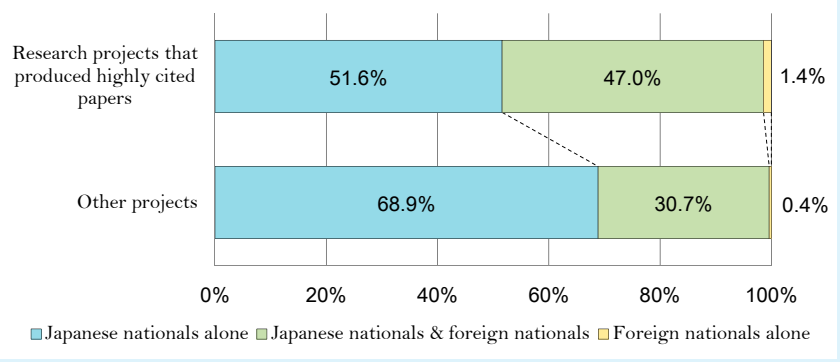
Note 1. "International students" mean foreign-born students; "foreign students" mean domestic-born students with foreign citizenship.
Note 2. Data used are those as of 2010 for Canada and South Africa, and as of 2011 for the other countries.
Source: MEXT based on *Education at a Glance 2013*, OECD

(2) Importance of international researchers

1) Contributions by international researchers in highly cited scientific papers

Participation by international researchers in research projects helps to improve the quality of research in Japan. For example, a NISTEP survey shows that 47.0% of the research projects that generated the top 1% most cited papers had participation by both Japanese and international researchers. Only 30.7% of projects that produced other papers (i.e., randomly selected papers other than highly cited ones) had participation by international researchers (Figure 1-2-56).

Figure 1-2-56 / Participation by International Researchers in Research Projects That Produced Highly Cited Papers



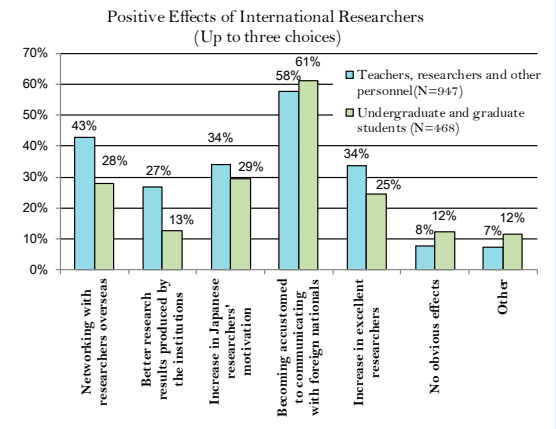
Note: "Research projects that produced highly cited papers" refers to projects that produced the top 1% most cited scientific papers, and "other projects" refers to projects that produced other papers (i.e., randomly selected papers other than highly cited ones).
Source: *Knowledge Creation Process in Science*, Survey Material 191, Joint Research Team of NISTEP and Hitotsubashi University Institute of Innovation Research (IIR), November 2010

2) Positive effects of international researchers

International students and researchers help to motivate Japanese researchers. According to a MEXT survey[1], 90% of the Japanese students, faculty, researchers and other staff at universities that accept international students and researchers recognize positive effects from foreign nationals. Many of the respondents to the survey said that international students and researchers help Japanese to become accustomed to communicating with foreign nationals and help to develop networks with researchers overseas (Figure 1-2-57).

The survey suggests that the experience of working with international researchers helps Japanese researchers to relieve their concerns about doing research overseas and encourages them to be positive toward opportunities of working abroad.

Figure 1-2-57 / Positive Effects of International Researchers

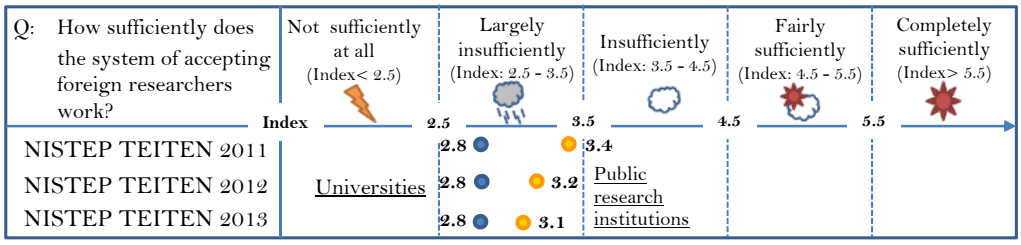


Source: MEXT, February 2014

(3) Perceptions held by international researchers

According to the NISTEP TEITEN survey, it is recognized that Japanese research institutions are not well-prepared to receive international scientists (Figure 1-2-58). To create research environments attractive to international researchers, their motivations for working in Japan, as well as the problems they face in Japan, are analyzed below.

Figure 1-2-58 / Recognition of the Situation Regarding Preparedness to Accept International Researchers (Expert Survey Results)



Source: *Expert Survey on Analytical Report for 2013 NISTEP Expert Survey on Japanese S&T and Innovation System (2013 NISTEP TEITEN survey)*, NISTEP, April, 2014

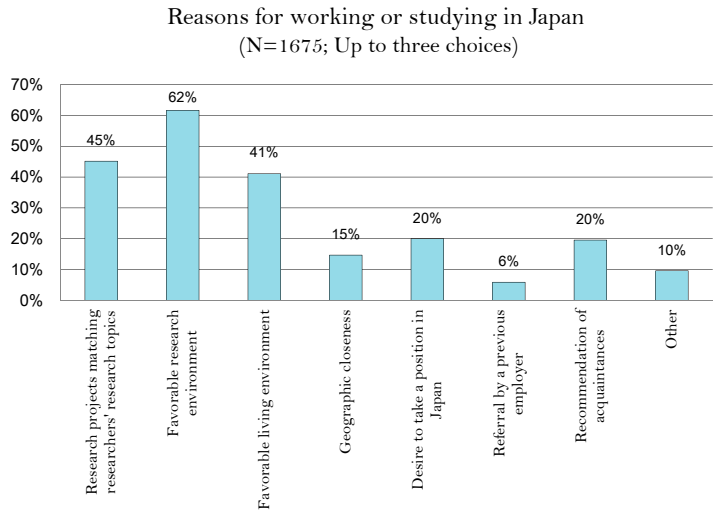
1) Reasons why international researchers work in Japan

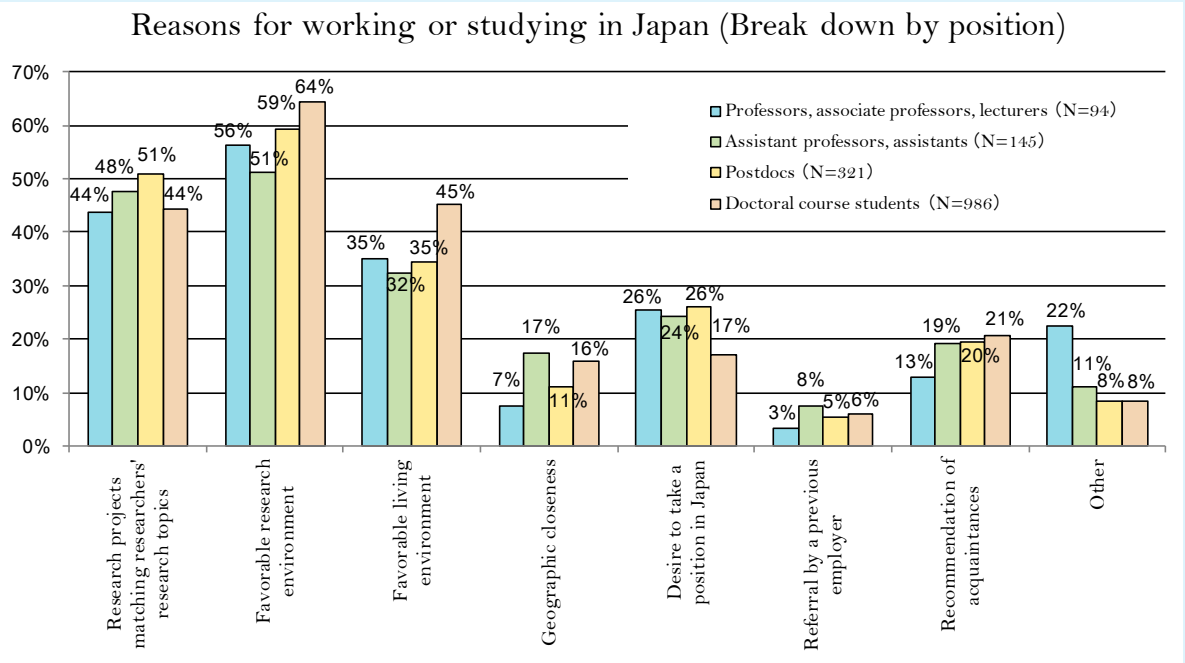
The *Survey on the Perceptions Held by International Researchers* indicates that international students and

1 In February 2014, MEXT conducted a survey on the positive effects of international researchers as perceived by Japanese researchers working with international researchers at 16 Japanese organizations
(Hokkaido University, Tohoku University, University of Tsukuba, University of Tokyo, Tokyo Institute of Technology, Nagoya University, Kyoto University, Osaka University, Kyushu University, Keio University, Waseda University, Okinawa Institute of Science and Technology Graduate University, High Energy Accelerator Research Organization, RIKEN, National Institute for Materials Science, and AIST). Respondents at universities were those specializing in science and engineering. Valid responses were given by 1,415 respondents. (Conducted concurrently with the *Survey on the Perceptions Held by International Researchers*, shown in Figure 1-2-52)

researchers chose to come to Japan because of the research environments available in Japan, research projects matching their research topics and the favorable living environment. Young researchers such as assistant professors, research associates and postdocs more highly value research projects that match their research topics than researchers in other positions do, and graduate students place more emphasis on the living environment than other researchers do (Figure 1-2-59).

Figure 1-2-59 / Reasons for Working or Studying in Japan

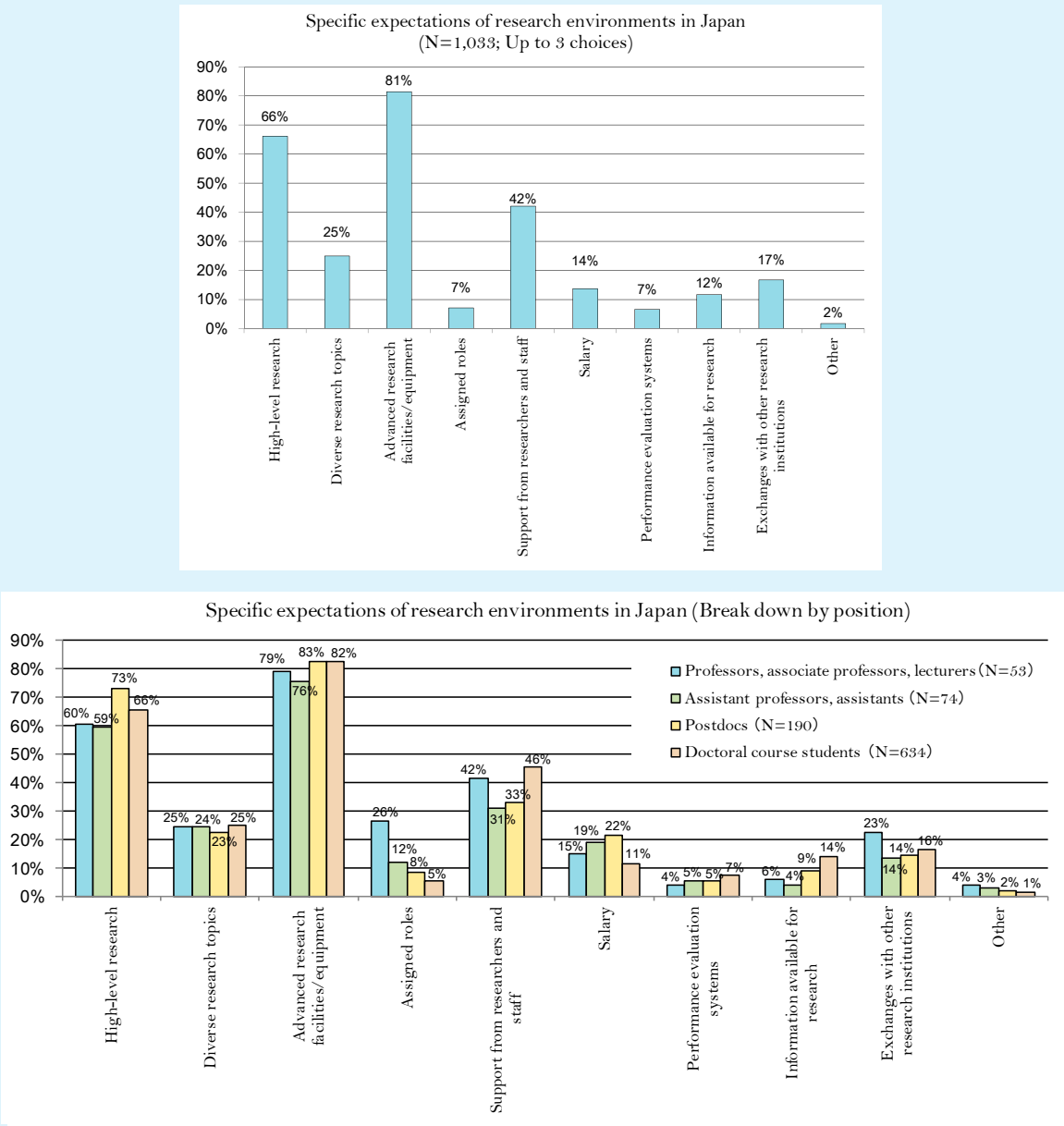




Source: *Survey on the Perceptions Held by International Researchers*, MEXT, February 2014

By "research environments", young international researchers specifically mean research and laboratory facilities and high-level research. In comparison with researchers in other positions, postdocs place stronger emphasis on high-level research, and faculty members including professors, associate professors and lecturers weigh the roles assigned to them more heavily (Figure 1-2-60). Thus, what international researchers expect from Japan varies slightly depending on their position.

Figure 1-2-60 / Specific Expectations of Research Environments in Japan

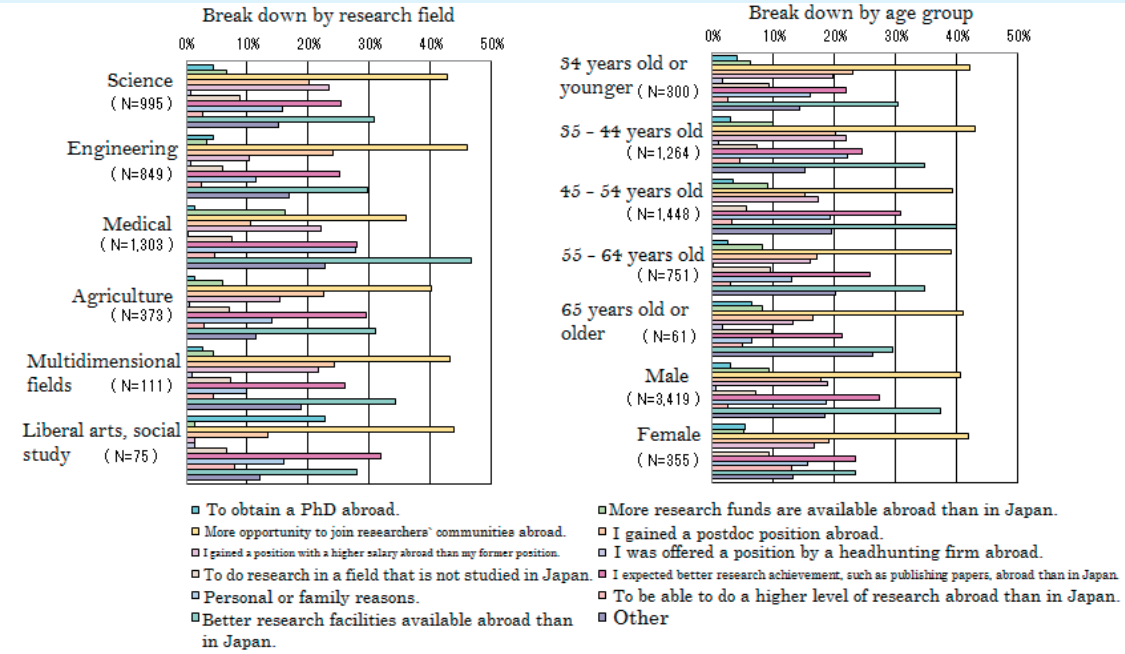


Source: *Survey on the Perceptions Held by International Researchers*, MEXT, February 2014

2) Reasons why Japanese researchers work overseas

According to a NISTEP survey, Japanese researchers choose to engage in research abroad or are willing to do so mainly because they want to join international research communities, because they think it easier to produce research results and papers abroad than in Japan or because they want to work at institutions with excellent research facilities (Figure 1-2-61). In addition to the reasons that the survey respondents choose from, some respondents gave other reasons. These respondents choose to work overseas in order to take part in international joint research projects, to be employed as researchers working overseas, to improve their language skills, to broaden their perspectives or to be freed from miscellaneous tasks irrelevant to research. The lack of positions in Japan was another reason.

Figure 1-2-61 / Reasons Why Japanese Researchers Wish to Engage in Research Overseas



Source: *A Survey about Mobility of Researchers and Diversity of Research Organizations*, NISTEP Report No. 123, NISTEP, March 2009

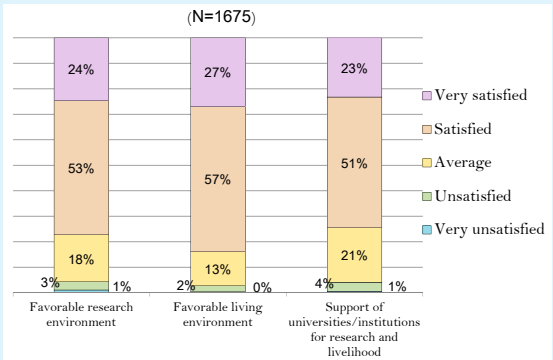
All the reasons mentioned above are similar to the major reasons why international researchers choose to work in Japan. Therefore, the efforts necessary for ensuring the growth in the number of talented international researchers working in Japan include increasing the research areas where international researchers can assume pivotal roles in research communities, creating research environments that enable international researchers to write and publish papers in English, enhancing the authority of and confidence in Japanese scientific journals, and improving research facilities.

3) Satisfaction levels of international researchers

In the *Survey on the Perceptions Held by International Researchers* regarding international researchers' satisfaction with Japan, more than 70% of the respondents said they were satisfied or very satisfied with the research environment, the living environment and the support of universities/institutions for research and livelihood (Figure 1-2-62).

Specifically, regarding research environments, the respondents are satisfied with the research and laboratory facilities and the high level of research. As for support offered by universities and institutions, the respondents are particularly satisfied with support for administrative procedures and communication in foreign languages. However, only very small percentages

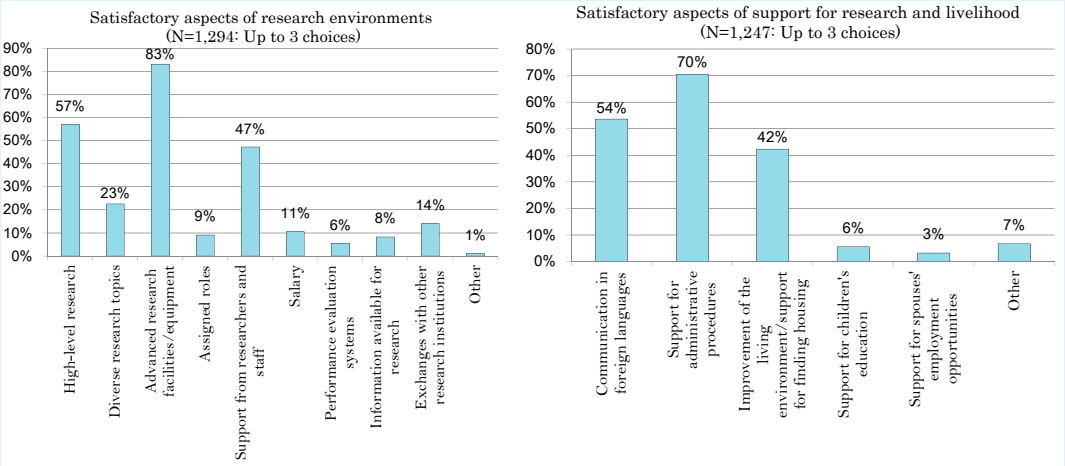
Figure 1-2-62 / Levels of Satisfaction with Japan



Source: *Survey on the Perceptions Held by International Researchers*, MEXT, February 2014

of respondents reported being satisfied with the performance assessment systems in the research environments and with support for their children's education, as well as for their spouses' employment opportunities (Figure 1-2-63). In a separate question surveying regarding international researchers' satisfaction, the respondents reported being not very satisfied with support for their children's education and for their spouses' job opportunities (Figure 1-2-64). The aspects with which international researchers are dissatisfied need to be addressed urgently.

Figure 1-2-63 / Specific Aspects of Research Environments and Support That International Researchers are Satisfied with



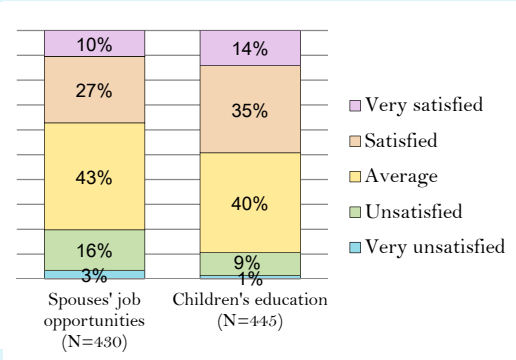
Note: Questions were given only to the respondents who were satisfied or very satisfied with research environments and support for research and livelihood

Source: *Survey on the Perceptions Held by International Researchers*, MEXT, February 2014

4) Hopes of international researchers

According to the *Survey on the Perceptions Held by International Researchers*, 27% of the respondents (or 47%, when respondents who answered "undecided" are excluded from calculation) reported a desire to find employment or to continue research in Japan. Respondents who choose to take positions in their home countries or countries other than Japan and their home countries do so chiefly because positions are unavailable in Japan, because research environments in Japan are not adequate, because they find problems in the living environment of Japan, because they have family members (parents, spouse, children) in their home countries, because they wish to contribute to the development of their home country, because it is difficult to master the Japanese language or because they want to gain additional experience in other countries. More international researchers at universities/institutions having career

Figure 1-2-64 / Satisfaction with Support for Spouses' Job Opportunities and Children's Education

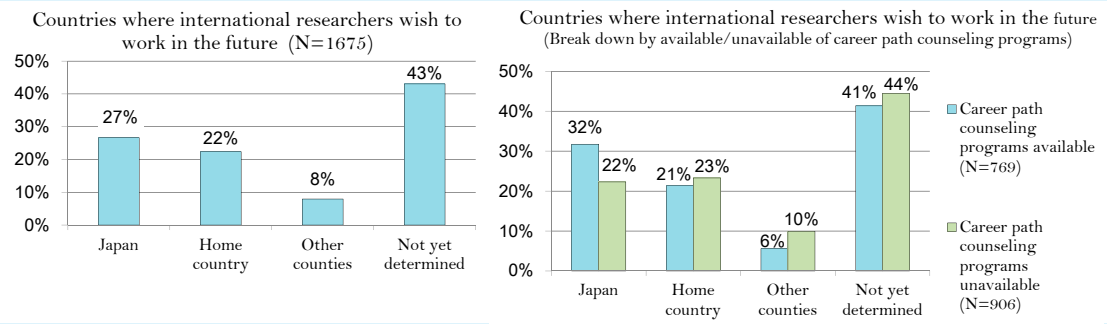


Note: Questions were given only to respondents whose spouses wished to work or who had children.

Source: *Survey on the Perceptions Held by International Researchers*, MEXT, February 2014

path counseling programs expressed a wish to work or continue their research in Japan in comparison to international researchers at universities/institutions without career path counseling programs (Figure 1-2-65).

Figure 1-2-65 / Countries Where International Researchers Wish to Work in the Future



Source: *Survey on the Perceptions Held by International Researchers*, MEXT, February 2014

(4) Future directions of efforts

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

First, radical improvement of research environments is needed in order to attract world-leading researchers to Japan. International researchers choose to work in other countries because they value the high level of research and the advanced research facilities in those countries. Thus, it is imperative to increase the number of research areas in which Japan can lead the world and to develop research centers focusing on these research areas where talented researchers from many countries gather and work,learning from each other. At these research centers, desirable research environments need to be in place. For example, English should be the common language, and roles, performance evaluation criteria and pay systems should match job categories and conform to international standards. It is also necessary to help international researchers eliminate the language and cultural barriers they may face in Japan. In this regard, support to children's education and spouses' employment opportunities should be enhanced.

Additionally, it is absolutely necessary to use English in publishing scientific journals and in making presentations at academic meetings, and to enhance the authority of and confidence in Japanese scientific journals.

Second, it is necessary to accept an increasing number of excellent international students and to encourage them to take positions in Japan. Many of the international researchers, and especially more than half of the researchers from Asian countries, first came to Japan as students. If Japan can attract talented young researchers from emerging countries that have been rapidly advancing their science and technology, they will greatly contribute to the vitalization of scientific activities in Japan, the creation of knowledge and solutions to complex scientific issues.

Because the availability of career path counseling programs affects international students' choice of countries they take positions in, universities and institutions accepting international students need to develop career path counseling programs.

Third, programs for sending young Japanese researchers abroad and programs for accepting international researchers need to be promoted in an integrated manner toward developing international research networks centered on Japan. Because research institutions in Japan are mostly outside the network of international research institutions from the viewpoint of researchers' international mobility, it is urgently necessary to enhance Japan's international standing by sending an increasing number of Japanese researchers overseas and to accept more international researchers in Japan. Strategic dissemination of information about the appeal of Japan's S&T research is also very important.

(5) Specific projects

In fact, multiple programs have been implemented in Japan in line with the future direction outlined above. Major programs, their results so far and associated issues are summarized below.

1) World Premier International Research Center Initiative

In FY2007, MEXT started the *World Premier International Research Center Initiative (WPI)* to develop research centers at which international front-line researchers are willing to work. These research centers also help talented scientists to be internationally mobile. As of FY2013, the *WPI* supports projects at nine research centers[1]. Intensive government support has been provided to the universities and institutions that have these research centers, in order to promote systemic reforms, including the development of international-standard research administration and environments.

At the research centers that were selected initially[2], foreign nationals account for 30-55% of the researchers, and the share reached 55.4% as of the end of FY2012 at one of these research centers. Research projects at these research centers have produced papers whose scientific quality is on par or superior to the quality of papers published by world-leading universities[3]. Increasing the number of excellent researchers working at these research centers has helped to attract young researchers from prominent institutions abroad, creating a virtuous cycle.

It is particularly worth noting that these research centers have been successfully implementing systemic reforms that were difficult to realize in the past. For example, they recruit researchers by following recruiting procedures implemented in the English language only, in accordance with international standards; they recruit overseas; and they use compensation systems based on merit and ability, as well as using flexible faculty work rules. These systemic reforms should not be limited to the initially selected research centers. They should be regarded as precedents that other departments at the universities having these research centers, and other research institutions, are required to follow.

2) Internationalization of education programs and other systems at universities

With the aim of promoting internationalization on campus, MEXT launched the *Project for Establishing University Network for Internationalization (Global 30)* in FY2009. Under this project, 13 universities were selected from among applicants for starting degree programs in English (Figure 1-2-66, Figure 1-2-67),

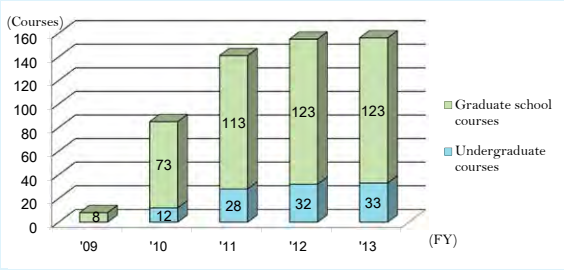
1 These nine research centers include the three WPI focus research centers that started in FY2012
2 These are the five research centers selected in FY2007.
3 According to the interim assessment of the five initially selected research centers, 5.1% of the papers published from 2007 through 2010 ranked in the top 1% of most-cited papers worldwide. This percentage is higher than those of prestigious universities in the USA, such as Massachusetts Institute of Technology, Princeton University and Harvard University.

and for internationally recruiting foreign faculty (Figure 1-2-68, Figure 1-2-69).

The Re-Inventing Japan Project, which started in FY2011, has been promoting exchanges of students and faculty members between Japanese universities and collaborating universities in the USA and Asian countries. Since FY2012, the Project for Promotion of Global Human Resource Development has selected 42 universities for enhancement of the globalization of education systems at these universities through international recruitment and employment of foreign faculty members, and the like.

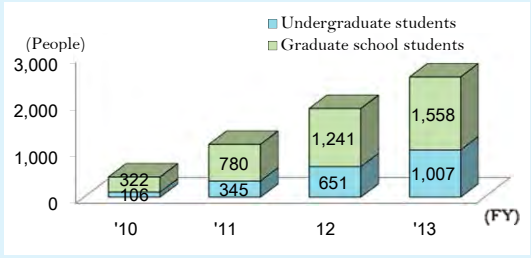
These projects have helped to increase the number of international students and faculty members at each of the universities implementing the projects.

Figure 1-2-66 / Changes in the Number of Courses Taught in English at the 13 Universities under the Global 30 Project



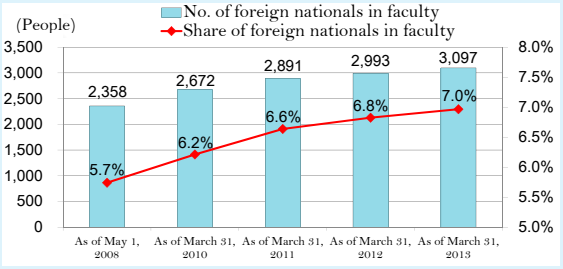
Source: MEXT

Figure 1-2-67 / Changes in the Number of International Students Learning in Courses Taught in English at the 13 Universities under the Global 30 Project



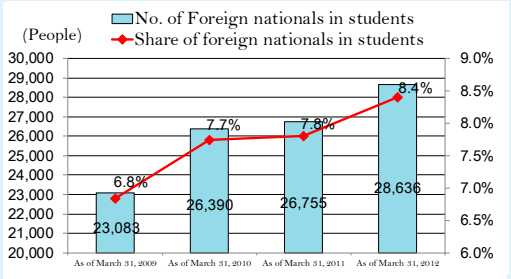
Note: Data are as of Oct. 1 of each year.
Source: MEXT

Figure 1-2-68 / Changes in the Number and the Share of Foreign Nationals in Faculty at the 13 Universities under the Global 30 Project



Source: MEXT

Figure 1-2-69 / Changes in the Number and the Share of Foreign Nationals in Students at the 13 Universities under the Global 30 Project



Source: MEXT

3) Program for promoting the enhancement of research universities

The Program for Promoting the Enhancement of Research Universities, launched by MEXT in FY2013, provides support to research universities in order to increase excellent, world-class research. The 22 universities selected in FY2013 for this project have programs for enhancing their research capabilities and have set various targets under the policy of ability enhancement through the employment and efficient use of research administrators combined with intensive reforms of research environments.

Toward reforming their research environments, a numerical target is set for increasing the number of international researchers. Osaka University, for example, aims at increasing its share of foreign nationals in the faculty from 4.0% in May 2012 to 10% in FY2022 by planning and starting international joint research projects, enhancing the ability of the administrative office to communicate with foreign nationals and helping international researchers to obtain research funds. Hiroshima University set a goal of increasing the number of subjects taught in English from the current 300 to 1,600 by FY2017 for the purpose of increasing the number of international students. Setting goals like those set by these two universities is expected to help promptly enhance the diversification of human resources at universities and inter-university research institutes in Japan.

4) Postdoctoral Fellowship for Overseas Researchers

The Japan Society for the Promotion of Science has been implementing the JSPS Postdoctoral Fellowship for Overseas Researchers in order to recruit talented young researchers from various countries so as to help raise the standards of Japan's academic research and promote internationalization of research environments in Japan. This fellowship program provides opportunities for young postdoctoral researchers from overseas to engage in cooperative research under the guidance of host researchers in humanities, social science and natural sciences. The financial support provided to the accepted postdoctoral researchers covers airfares, maintenance allowances, settling-in allowances, overseas travel insurance costs, and the like. In FY2013, 1,228 postdoctoral researchers were accepted by this program. In the future, more strategic programs for accepting postdoctoral researchers are desired.

5) Increase of opportunities to apply for research funding in English

To expand the employment of excellent international researchers, it is essential to make it easier for foreign nationals working at Japanese research institutions to apply for and obtain publicly offered research funds.

Recently, it has been increasingly possible for international researchers to apply for research funding in the English language. In FY2013, application procedures were published in English by the *Grants-in-Aid for Scientific Research*, *JST Strategic Basic Research Programs (Creation of New Technological Seeds)*, and the *Impulsing Paradigm Change through Disruptive Technologies (ImPACT) Program*. Foreign nationals can use English in applying for research funds provided by these programs. Further improvements for the use of English in application procedures are desirable, so that international researchers will have more opportunities to apply for research funding.

6) Preferential treatment concerning immigration

Certain measures concerning immigration are important for increasing the number of international researchers in Japan. In May 2012, the Ministry of Justice started point-based preferential immigration treatment for highly skilled international professionals[1]. The preferential treatment, which helps to encourage international researchers to stay in Japan for a prolonged period of time, includes: grant of a

1 The activities of highly skilled foreign nationals are classified into three categories: (1) advanced academic research activities, (2) advanced specialized/technical activities and (3) advanced business management activities. According to the characteristic features of each category of activities, evaluation will be made by setting points to such items as "educational attainment", "period of professional experience" and "annual salary". Personnel who earn 70 points or more in the point evaluation are recognized as highly skilled foreign professionals and are given preferential immigration treatment.

"5-year" period of stay, relaxation of requirements for granting of permission for permanent residence in line with the history of staying in Japan, permission for the spouse of a highly skilled international professional to work and permission for bringing parents of a highly skilled foreign professional under certain conditions.

In December 2013, the Ministry of Justice eased its requirements for highly skilled foreign professional status to encourage more foreign nationals to apply for positions in Japan. For example, the minimum qualifying annual salary was reduced, more points are awarded for advanced academic research activities, and degrees at a higher education institution in Japan and other qualifications and requirements were revised for those who wish to come to Japan with their parents. These systemic reforms are expected to help increase the number of international researchers taking positions in Japan.

7) Global dissemination of Japan's attractive science and technology research information

With the aim of informing the world of the excellence of Japan's advanced science and technology, MEXT has been implementing the *Research in Japan* campaign. As part of this campaign, MEXT has been improving its website content and has expanded its public relations activities globally by setting up a "Japan booth" and distributing leaflets at international events. The further development of these PR activities is expected to have positive results in increasing the number of international researchers in Japan, not only in the short term, but also in the medium and long terms.

8) Efforts desired in the future

Efforts for improving the systems and environments toward increasing the number of world-leading international researchers in Japan, like those described above, should be promptly made by many other universities and institutions as well. However, adequate programs and systems have not been developed for performance evaluation and employment of international researchers, as well as support for their families. Universities and institutions need to review and improve the situation in this regard. Active cooperation by local governments and private companies are required in order to ensure support for international researchers regarding their children's education and their spouses' employment opportunities.

When institutions specializing in R&D introduce more flexible compensation systems, such as annual salary systems and merit pay plans, and when they reform their personnel systems to improve the treatment of researchers according to the *Basic Policy on the Reform of Independent Administrative Institutions*, they will be able to employ more highly qualified international researchers.

In December 2013, MEXT formulated the *Strategy to Attract International Students for Japan's Integration with Global Growth*, in connection with efforts for increasing international students. This strategy stipulates the priority research areas and countries/regions on which the efforts to attract international students should focus, and it proposes necessary measures, such as the employment of coordinators for international students, increased and improved use of scholarships, and livelihood support to international students in cooperation with local communities. Steady implementation of these measures is hoped for.

In FY2014, JST started the Japan-Asia Youth Exchange Program in Science. In this program, talented youths are invited from Asian countries for scientific interchanges while visiting Japanese universities, public research institutions and public companies, and for learning about leading-edge S&T in Japan. About

2,000 Asian youths visited Japan under this program in FY2014. The program is expected to result in the recruitment of excellent researchers in S&T innovation.

Toward the creation of a global research network, the Top Global University Project, a MEXT project launched in FY2014, focuses on support to universities that advance internationalization radically through exchanges and collaboration with world-leading universities and through reforms of personnel and administration systems. It is hoped that the universities that are selected for this project will contribute to the development of an international network of researchers and, thus, will help to accelerate the internationalization of Japanese society.

In the mid- and long-term perspective, it is also important to assist Japanese researchers or international researchers who have worked or studied at Japanese universities in taking positions at universities overseas, so that these researchers will help enhance Japan's presence in international research networks. When excellent international students who have learned under these researchers choose to engage in research in Japan in the future, researchers working in Japan will be more diverse and the level of research in Japan will be advanced at an accelerating pace. Many of the foreign nationals who have studied or conducted research in Japan play active roles at research institutions and universities in their home countries and often form associations of people having experience of working/studying in Japan. Interchanges with, and support for, these people and associations are also meaningful.

Column 1-11

Programs Implemented by the National Institute for Materials Science (NIMS)

While the number of international researchers working at independent administrative institutions as a whole has not been substantially increasing, foreign nationals account for 36.7% of the researchers at the National Institute for Materials Science (as of FY2013). Programs implemented by this institute are shown below.

At the National Institute for Materials Science, the International Center for Materials Nanoarchitectonics (MANA), one of the research centers selected by MEXT for the World Premier International Research Center (WPI) Initiative, has been playing a pivotal role in developing a global network and a center of excellence regarding research materials science. Specific programs implemented by NIMS include the following: the NIMS International Center for Young Scientists (ICYS) program[1] for accepting young researchers and sending researchers to research institutions in Japan and overseas (25 researchers in FY2013), the International Cooperative Graduate Program[2] for accepting overseas doctoral students as NIMS visiting scientists (23 students in FY2013), the NIMS Internship Program for accepting undergraduate and graduate students (105 students in FY2013), the National Nanotechnology Infrastructure Network (NNIN) supported by the NSF for providing undergraduates with an opportunity for short-term internships (10 students in FY2013), the NIMS-WUT Summer Training for accepting undergraduates and master's students from Warsaw University of Technology for short-term internships (10 students in FY2013) and globalization programs for training administrative staff and engineers to have command of two languages.

NIMS also has unique features in the livelihood support given to researchers and in recruiting activities.

Regarding international researchers working at NIMS for 91 days or longer, for example, NIMS facilitates the steady progress of research by providing livelihood support to them and their families. Specifically, researchers and their families are assisted in solving various everyday problems such as opening bank accounts and finding housing. Because NIMS is a member of the Tsukuba Science City Network, children of the researchers at NIMS can benefit from reduced tuition at Tsukuba International School, which has a cooperative agreement with Tsukuba Science City Network. Japanese language lessons are available twice a week in introductory, beginner and other courses. A program in which participants learn about Japanese culture is provided once a month to international researchers and their families.

In order to recruit researchers, NIMS advertises in *Nature*, *Science* and other journals, and informs guests from overseas research institutions and universities visiting NIMS of the diverse programs available for accepting researchers. NIMS also conducts job interviews with candidates living abroad via teleconferencing.

Through all these activities, NIMS has significantly increased the number of foreign nationals as a share of NIMS researchers and has raised its international profile as a research institution. It is hoped that universities and independent administrative institutions in Japan will follow the fine example of NIMS in actively implementing effective programs.

1 International Center for Young Scientists: An organization where young multinational independent researchers gather to conduct research autonomously.

2 International Cooperative Graduate Program: A program for accepting talented doctoral students from graduate schools overseas as NIMS trainees who undergo training by NIMS researchers on research.