# Impact of Research Team Characteristics on Knowledge Creation in Science: Descriptive Statistics from Hitotsubashi-NISTEP-Georgia Tech Scientists' Survey[1]

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## Abstract

This research in progress paper reports the descriptive statistics regarding the involvement of young scholars in knowledge creation; internationalization of research teams; and the combination of knowledge in research teams, based upon results of the large-scale survey of Japanese and US scientists. It was found that young scholars (students and postdoctoral fellows) are important contributors for research efforts in both countries. PhD students and postdoctoral fellows are often the first authors of top 1% highly cited papers. In the US, postdoctoral fellows are the first author on half of the highly cited papers in life sciences. The involvement of young foreign-born scholars is important in both countries. It accounts for more than 70% of the first authors of highly cited papers in the US and around one-third in Japan. The US teams are significantly more diversified in the origins of birth than the Japanese teams (For highly cited papers, 80% of teams in the US involve scientists from more than one country vs. 50% in Japan). About 80% of domestic papers involve at least one foreign-born scientist in the US reflecting the large inflow of foreign-born scholars to the US.

## Background and purposes

Recent studies on scientific research show that the unit of scientific research has increasingly shifted from an individual to a team (Adams & *al.*, 2005; Wuchty, Jones & Uzzi, 2007), involving multiple organizations rather than a single organization, and increasingly international rather than strictly domestic (NISTEP, 2011). The research on science mapping also suggests that inter/multi-disciplinary research areas, which require combination of knowledge from different fields, have emerged broadly in science (Saka, Igami & Kuwahara, 2010).

These literatures indicate that how to design and manage a research team has become an increasingly important issue. However, the bibliographic information alone provides only limited

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[1] This research has been being conducted in collaboration between Institute of Innovation Research (IIR) of Hitotsubashi University and National Institute of Science and Technology Policy (NISTEP) as a part of "Industry-university-government joint research on the innovation process" with support of Special Funds for Education and Research of The Ministry of Education, Culture, Sports, Science and Technology. This work has also been supported by JSPS KAKENHI 21243020. Georgia Institute of Technology implemented the survey in the US in collaboration with IIR and NISTEP.

information on who are the scientists, including their academic position, origin of birth, disciplinary diversity, and diversity in skills. To authors' knowledge, there are no comprehensive studies that examine the impact of team characteristics on the knowledge creation process in science. This paper aims to contribute to widen our collective knowledge on the relationship between research team charcteristics and its impact on knowledge creation with special emphasis on the role of young scholars, internationalization of research team, and diversity of the fields of expertise in research team.

The results of the Hitotsubashi-NISTEP-Georgia Tech scientists' survey on the knowledge creation process in science were used for the analysis. The survey in Japan was jointly conducted by the Institute of Innovation Research (IIR) of Hitotsubashi University and the National Institute of Science and Technology Policy (NISTEP) from the end of 2009 to the summer 2010 (Nagaoka & *al.*, 2010). The survey in the US was implemented by the Georgia Institute of Technology, in collaboration with IIR and NISTEP, from autumn 2010 to early 2011 (Nagaoka & *al.*, 2011). It collected around 2,100 responses from scientists in Japan and 2,300 responses from scientists in the US on their research projects that generated scientific papers subjected to the surveys.

One advantage of the scientist survey is that it is a comprehensive and standardized micro-data set, covering the characteristics of research projects, the composition of the research team, research funding source used in the research projects, external knowledge sources that inspired the research project, serendipities in the research projects, outputs yielded by the research projects among others. In addition, the scientist survey also collected data on research projects which yielded top 1% highly cited papers and the research projects which yielded other papers (normal papers), in addition to our coverage of both the US and Japan. The rich data regarding research projects enable us to analyze the relationship between research team characteristics and performance of the research teams. Based upon the dataset obtained by the scientists' survey, the ultimate goal of our study is to address the following questions regarding the research teams.

1. What is the difference in the involvement of young scholars in Japan and the US? What is the impact of involvement of young scholars as the first author, especially when the contribution of authors to the paper was considered?
2. What is the situation of internationalization of research in Japan and the US? What is the impact of internationalization on the performance of research team?
3. What is the impact of combination of knowledge in different field of science on the knowledge creation?

This research in progress paper reports descriptive statistics regarding the involvement of young scholars in the knowledge creation; internationalization of research teams; and the combination of knowledge in research teams based upon Hitotsubashi-NISTEP-Georgia Tech scientists' survey.

## Overview of the surveys

### *Identification of possible focal papers*

The population of the survey was articles and letters in the Web of Science database of Thomson Reuters. Reviews were excluded from the population. The time window of the papers for the survey is from 2001 to 2006 (in the database year). Database year refers to the year when the documents are recorded into the database. The bibliographic information and the number of citations as of the end of December 2006 were used in the identification of the possible focal papers. Two sets of the possible focal papers shown below were selected from the population.

Highly cited papers (approximately 3,000 in each survey): Top 1% highly cited papers in each journal field[2] and in each database year; at least one organization of authors should be located in Japan for the Japanese survey and in the US for the US survey. All highly cited papers in the time window were selected for the Japanese survey and approximately 3,000 highly cited papers were randomly selected from the highly cited papers in the US survey.

Normal papers (approximately 7,000 in each survey): Randomly selected papers in each journal field and in each database year from the population of the survey, excluding the above highly cited papers; at least one organization of authors should be located in Japan for the Japanese survey and in the US for the US survey.

We covered all fields, including the social science, although the coverage of social science journals by the database is not comprehensive and we have a relatively small number of the publications by Japanese authors in this field. Social sciences were dropped from the rest of the analysis, given the small sample in Japan and the differences of research activities with natural sciences.

*Identification of possible survey targets and research projects for the survey*

Corresponding authors or equivalents of approximately 20,000 possible focal papers were investigated and identified as survey targets. If multiple papers were assigned to a single author, one paper was randomly selected as a focal paper while the priority was given to the highly cited papers in the selection process.

As a result, 7,652 survey targets were identified for Japanese survey. Of those, there are 1,932 scientists whose focal paper is the highly cited paper; and there are 5,720 scientists whose focal paper is the normal paper. In the US, 8,864 survey targets were identified. Of those, there are 2,882 scientists whose focal paper is the highly cited paper; and there are 5,982 scientists whose focal paper is the normal paper.

*Response rate*

Out of 7,652 survey targets, we got 2,081 responses in the Japanese survey. The total response rate is 27.2%. The response rate is 29.3% for the highly cited papers and 26.5% for the normal papers.[3]

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[2] The journal field refers the 22 scientific fields in the Essential Science Indicators ("ESI" hereafter) of Thomson Reuters.

[3] Although this survey had a relatively high response rate, the non-response rate was more than 70%. For this reason, it is necessary to examine whether there are some major sources of response biases. This note examines the response biases. First, there was a concern that a productive scientist with many good papers may not respond since he/she is busy. However, we found that survey targets producing one or more highly cited papers were more likely to respond this survey in both countries. Second, there was a concern that a paper with multiple authors might have a low response rate. In the US, there was no difference in response for multi-authored v. solo-authored papers. However, in each country, survey targets producing focal papers written by many authors or by authors in many countries seemed reluctant to respond this survey. For example, the response rate of survey targets producing a focal paper written by 50 or more authors was 17% in Japan and 21% in the US, which was significantly lower than the average response rate, although the survey targets accounted for only less than 1% of the samples. Third, survey targets in some sectors or types of affiliations seemed unwilling to respond the survey. In Japan, the response rates of survey targets staying in foreign countries, working at hospitals, and affiliated in business firms were 11%, 17%,

The total response rate in the US survey is 26.3%. We got 2,329 responses out of 8,864 survey targets. The response rate is 27.7% for the highly cited papers and 25.6% for the normal papers.

*Field classification for the analysis*

Results of the survey to be presented in this paper are based on 10 fields, aggregated from 22 ESI journal fields. Some results are based on 3 broad fields obtained by a further aggregation of the 10 fields, i.e. physical sciences, medicine, and life sciences. Natural sciences represent the aggregation of physical sciences and life sciences. Papers of multidisciplinary fields, those published in the journals like *Nature* and *Science*, are reclassified into one of 21 fields based on the backward citations of the multidisciplinary papers.

*Data available in the scientists' survey*

We have constructed comprehensive and standardized micro-data set from the two surveys, covering the characteristics of research projects, the composition of the research team, research funding used in the research projects, external knowledge sources that inspired the research project, serendipities in the research projects, outputs yielded by the research projects among others.

As for the composition of the research team, scientists' survey asked a respondent to identify the authors' academic position in the organization, academic field of expertise, the country of birth, specialized skill, the sector of the organization with which the author was affiliated. This question on the author profile was asked for all authors when the number of authors is 6 or less and for up to 6 authors, the first, last and corresponding authors and the randomly selected authors, when the number of authors is 7 or more. In addition to the information obtained by the survey, information of the number of authors and affiliations of authors were retrieved from the Web of Science.

**Distribution of authors**

This paper focuses on research team in the higher education institutions (HEIs)[4] and in natural sciences.[5] Figure 1 shows the distributions of the number of authors by field in our samples.[6] The number of authors varies significantly across scientific fields, but is quite similar between Japanese and the US samples. Since the number of authors varies significantly even in a specific scientific field, we use the medians for the following comparison across fields.

The count of authors is small in "computer science & mathematics," while it is large in "basic life sciences" and "clinical medicine & psychiatry/psychology." The range of the author counts between the first and the third quartile for "physics & space science" is not especially large, but the gap between the median and the mean is very large. This reflects the existence of outliers, the papers with a huge number of authors (more than 200), on such subject as particle physics.

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and 23%, which were lower than the average.  We also find below average response rates for firms (but not hospitals) in the US.

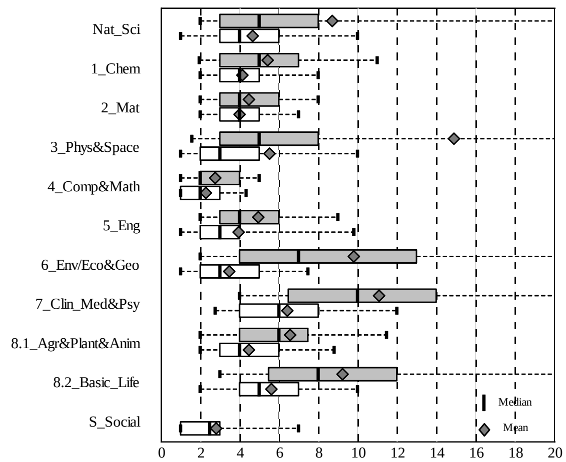
[4] The survey asked a researcher to identify the sector of the organization with which he/she was affiliated when the focal paper was submitted. This sector is used for analysis.

[5] Natural sciences is the aggregation of 1_Chem(istry); 2_Mat(erials Science); 3_Phy(sics)&Space (Science); 4_Com(puter Science)&Math(ematics); 5_Eng(ineering); 6_Env(ironment)/Eco(logy)&Geo(sciences); 8.1_Agr(icultural Sciences) & Plant & Anim(al Science); 8.2_Basic Life (Sciences).

[6] The number of authors in each focal paper was retrieved from the Web of Science.

The number of authors tends to be larger for the highly cited papers than the normal papers in most fields. The variation of the number of authors is large in “clinical medicine & psychiatry/psychology” and “basic life sciences” in both Japanese and the US samples; and is large in “environment/ecology & geosciences” especially in Japanese samples. In these fields, the maximum size of the research team is also very large.

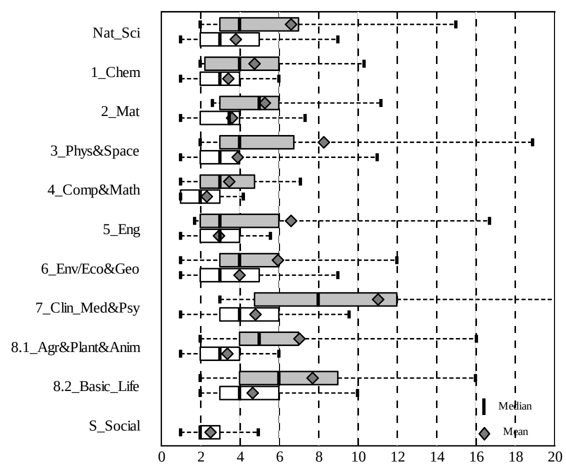
(a) Japan




unit: authors

| Respondents | Minimum | Q1 | Median | Q3 | Maximum | Average |
|---|---|---|---|---|---|---|
| 343 | 1.0 | 3.0 | 5.0 | 8.0 | 250.0 | 8.7 |
| 987 | 1.0 | 3.0 | 4.0 | 6.0 | 183.0 | 4.7 |
| 60 | 1.0 | 3.0 | 5.0 | 7.0 | 20.0 | 5.4 |
| 149 | 1.0 | 3.0 | 4.0 | 5.0 | 12.0 | 4.1 |
| 27 | 1.0 | 3.0 | 4.0 | 6.0 | 13.0 | 4.5 |
| 81 | 1.0 | 3.0 | 4.0 | 5.0 | 8.0 | 4.0 |
| 92 | 1.0 | 3.0 | 5.0 | 8.0 | 250.0 | 14.9 |
| 204 | 1.0 | 2.0 | 3.0 | 5.0 | 183.0 | 5.5 |
| 12 | 1.0 | 2.0 | 2.0 | 4.0 | 5.0 | 2.8 |
| 54 | 1.0 | 1.0 | 2.0 | 3.0 | 5.0 | 2.3 |
| 45 | 1.0 | 3.0 | 4.0 | 6.0 | 21.0 | 4.9 |
| 105 | 1.0 | 2.0 | 3.0 | 4.0 | 18.0 | 3.9 |
| 21 | 1.0 | 4.0 | 7.0 | 13.0 | 26.0 | 9.8 |
| 56 | 1.0 | 2.0 | 3.0 | 5.0 | 10.0 | 3.5 |
| 55 | 2.0 | 6.5 | 10.0 | 14.0 | 46.0 | 11.1 |
| 156 | 1.0 | 4.0 | 6.0 | 8.0 | 31.0 | 6.4 |
| 31 | 1.0 | 4.0 | 6.0 | 7.5 | 23.0 | 6.6 |
| 85 | 1.0 | 3.0 | 4.0 | 6.0 | 12.0 | 4.5 |
| 55 | 2.0 | 5.5 | 8.0 | 12.0 | 25.0 | 9.2 |
| 253 | 1.0 | 4.0 | 5.0 | 7.0 | 16.0 | 5.6 |
| - | - | - | - | - | - | - |
| 36 | 1.0 | 1.0 | 2.5 | 3.0 | 8.0 | 2.8 |

(b) US




unit: authors

| Respondents | Minimum | Q1 | Median | Q3 | Maximum | Average |
|---|---|---|---|---|---|---|
| 385 | 1.0 | 3.0 | 4.0 | 7.0 | 175.0 | 6.6 |
| 781 | 1.0 | 2.0 | 3.0 | 5.0 | 24.0 | 3.8 |
| 54 | 1.0 | 2.3 | 4.0 | 6.0 | 12.0 | 4.7 |
| 90 | 1.0 | 2.0 | 3.0 | 4.0 | 11.0 | 3.4 |
| 13 | 2.0 | 3.0 | 5.0 | 6.0 | 13.0 | 5.3 |
| 34 | 1.0 | 2.0 | 3.5 | 4.0 | 9.0 | 3.6 |
| 62 | 1.0 | 3.0 | 4.0 | 6.8 | 175.0 | 8.3 |
| 115 | 1.0 | 2.0 | 3.0 | 4.0 | 24.0 | 3.9 |
| 30 | 1.0 | 2.0 | 3.0 | 4.8 | 11.0 | 3.5 |
| 77 | 1.0 | 1.0 | 2.0 | 3.0 | 15.0 | 2.3 |
| 35 | 1.0 | 2.0 | 3.0 | 6.0 | 75.0 | 6.6 |
| 70 | 1.0 | 2.0 | 3.0 | 4.0 | 11.0 | 3.0 |
| 47 | 1.0 | 3.0 | 4.0 | 6.0 | 50.0 | 6.0 |
| 84 | 1.0 | 2.0 | 3.0 | 5.0 | 14.0 | 4.0 |
| 104 | 2.0 | 4.8 | 8.0 | 12.0 | 206.0 | 11.0 |
| 210 | 1.0 | 3.0 | 4.0 | 6.0 | 16.0 | 4.8 |
| 38 | 2.0 | 4.0 | 5.0 | 7.0 | 37.0 | 7.0 |
| 64 | 1.0 | 2.0 | 3.0 | 4.0 | 8.0 | 3.4 |
| 106 | 1.0 | 4.0 | 6.0 | 9.0 | 58.0 | 7.7 |
| 247 | 1.0 | 3.0 | 4.0 | 6.0 | 16.0 | 4.6 |
| - | - | - | - | - | - | - |
| 102 | 1.0 | 2.0 | 2.0 | 3.0 | 13.0 | 2.5 |

**Figure 1.** Distributions of number of authors by field in HEIs. Upper (shaded) boxplots indicate the distributions for the highly cited papers; and lower ones for the normal papers. Left end of boxes indicate the first quartiles; and right end of boxes the third quartiles. Left end of whiskers indicate the 5th percentile; and right end of whiskers the 95th percentile. The red bands in bars indicate the medians; and rhombi in bars the means.

## Academic positions of authors

The research team consists of a wide variety of human resources, such as graduate and undergraduate students, postdoctoral fellows, technicians, and professors or other scientists. There are several studies that show the importance of young scholars in the knowledge creation. It was found that about 30% of Quebec university papers have PhD students as authors or co-authors (Lariviere, 2010). Black & Stephan (2010) pointed out that PhD students and postdoctoral fellows appear disproportionately more as the first authors in the US articles in the

journal *Science*. We extend their analysis by covering all journals and by focusing on the publications where the order of the authors is according to their contributions.
Figures 2 (a) and (b) show composition of authors, in the HEIs, in Japanese and the US samples respectively. As for Japanese samples, the share of professors is the largest, followed by associate professor and assistant professors. Professors account for around 38% in the highly cited and 36% in the normal papers. On the other hand, young scholars, who are undergraduates, graduate students, or postdoctoral fellows, account for 28% of the authors of both types of papers. The percentage of postdoctoral fellows is significantly higher in the highly cited group (12% vs. 6%).

In the US samples, professors also account for the largest share in both the highly cited and normal papers. PhD students have the second largest share. The contribution of postdoctoral fellows is as large as that of PhD students in the highly cited papers. Young scholars, undergraduate students; PhD students; and postdoctoral fellows, account for 39% of the authors of the highly cited papers and 36% of the normal papers in the US samples. These results indicate more involvement of young scholars in the knowledge creation process in the US.

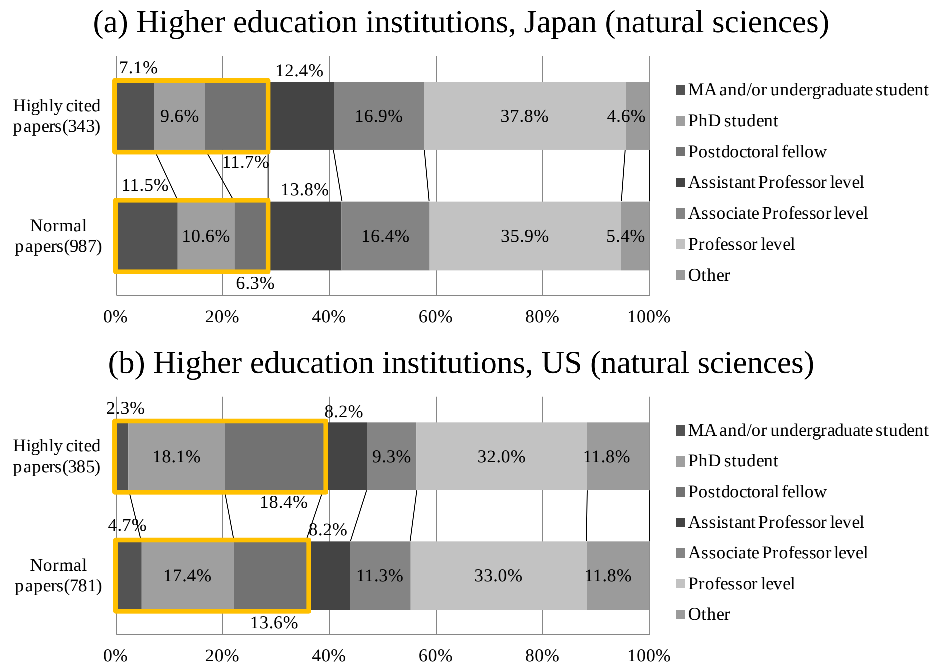



**Figure 2.** Compositions of authors in academic position (a paper basis, by sector, natural sciences). "Other" includes technician, the others and unknown.

Figure 3 shows the academic positions of the first authors of the focal papers in which authors are listed in order of their degree of contributions. In other word, it indicates the types of scientists who made the most contributions to the focal papers.

In the following discussion, we first look at the contribution of young scholars in the normal papers. As shown in Figures 3 (a) and (b), young scholars, account for 36% of the first authors in Japan and for 56% of the first authors in the US. Contribution of young scholars is more common in the US, compared to Japan. The share of young scholars as the first authors shows remarkable increase from that in the all authors in both countries. The contribution of young scholars is especially large in life sciences in both countries (see Figures 3 (d) and (f)). In life

sciences, 45% and 60% of the first authors are young scholars in Japanese and the US samples, respectively. In physical sciences, the young scholars account for more than 50% of the first authors in the US samples, while the share is around 30% in Japanese samples.
Contribution of postdoctoral fellows as the first author varies by the type of papers. The share of the postdoctoral fellows in the highly cited papers is very large in life sciences both in Japanese and the US samples. As we can see from Figures 3 (a) and (b), the composition of the postdoctoral fellows and students is different by the type of papers. The participation of students as the first author is more often in the normal papers compared to the highly cited papers.

Interpretation of these results should need some cautions. In positive side, it may reflect the inclusiveness of the US research system and young scholars' crucial roles in knowledge creation. However it may reflect S&T policy and tight labor market. In the US, the time window of the focal papers is overlapped with the doubling of the NIH budget. In the US, postdoctoral fellows, especially in life sciences, have difficulty to find tenure-track positions in higher education institutions and it is one of the political issues in national S&T policy (Stephan, 2012). The situation is similar in Japan. In the first S&T basic plan (FY1996-2000), Japanese government introduced a program to increase postdoctoral fellows up to 10,000 in order to strengthen Japan's research capability. The number of postdoctoral fellows showed remarkable rise in this period.

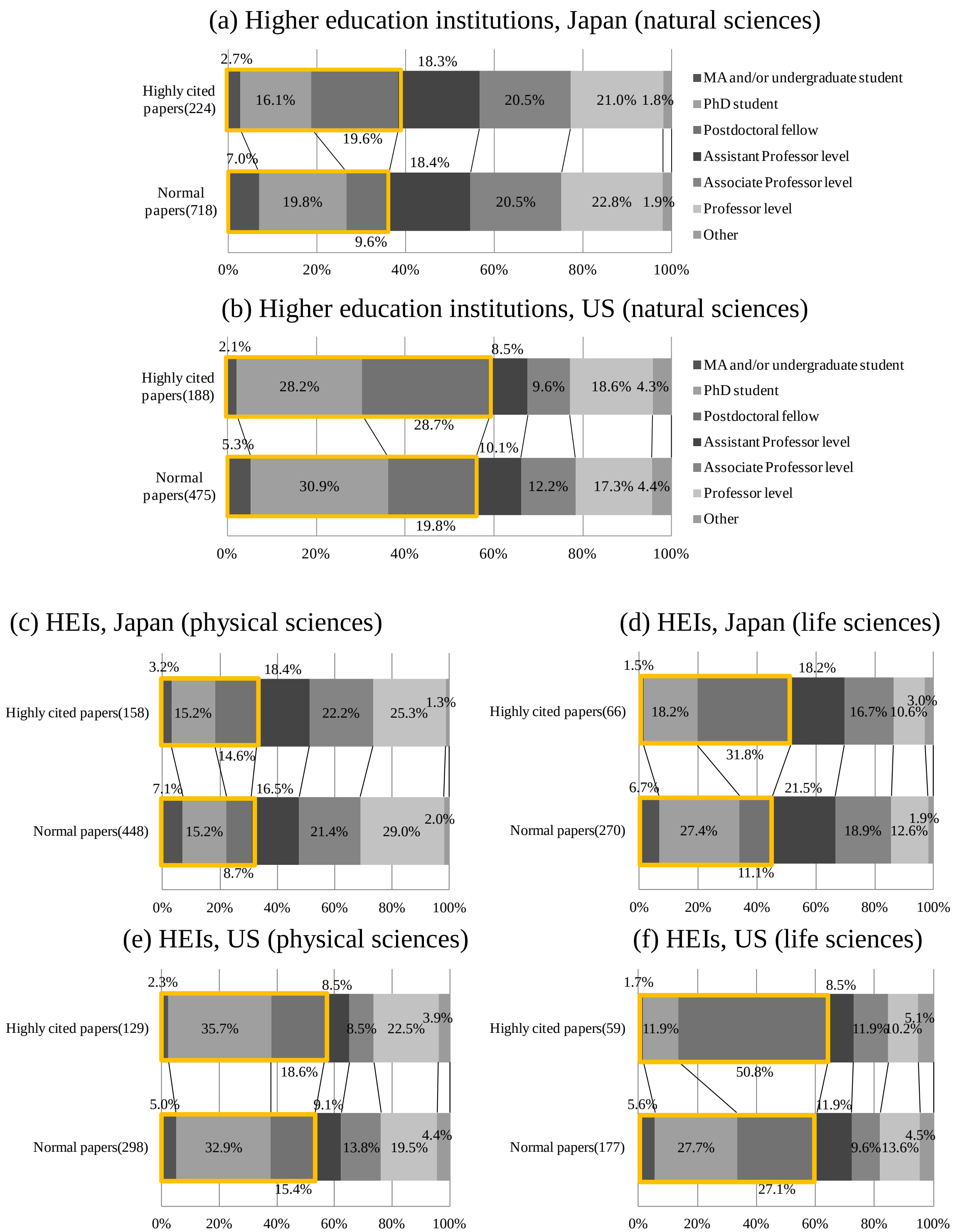



**Figure 3**. Academic positions of the first authors in the focal papers in which authors are listed in order of their degree of contributions.

**Internationalization of research team**

As for the internationalization of research teams, we will consider two aspects. One is the involvement of foreign-born scholars in the authors and another is the international co-authorship.

*Origin of birth of the first authors*

Analyses of the country of birth of scientists reveal striking difference in the team formation between Japan and the US. In the following, we focus on the first authors of the focal papers and investigate the differences in the origin of birth by the cohort of authors. As a proxy to measure the cohort of the authors, we used the academic position of authors. Young scholars include undergraduate students, master students, PhD students, and postdoctoral fellows. Senior authors include assistant professors, associate professors, professors, and other academic positions.

Table 1 (a) shows the country of birth of the first authors in the normal papers (HEIs and natural sciences). In the US samples, it was found that more than 60% of young scholars were born outside of the US and the US-born young scholars only account for 36% of the total. Among the foreign-born young scholars, China has the largest share. China-born young scholars reach to 16% of the total. European-born young scholars account for around 20% and Asia-born young scholars excluding Japan and China account for 15%. The results clearly show the US reliance on the foreign-born talents on knowledge creation process in science. The degree of reliance declines in senior scholars, the share of foreign-born scientists is around 50%.

As for Japanese samples, around 30% of young scholars and 10% of senior scholars are foreign-born. China-born and other Asia-born scientists are dominant in the foreign-born young scholars in Japanese samples.

Table 1 (b) shows the country of birth of the first authors in highly cited papers (HEIs and natural sciences). The share of foreign-born first authors increases in both young and senior scholars in Japanese samples, relative to normal papers. In highly cited papers, the share of China-born young scholars declines, while the share of European-born and US-born scientists increases remarkably. In the US samples, the share of foreign-born first authors also increases in young scholars, but it decreases in senior scholars.

**Table 1.** Country of birth of the first authors by the type of papers (HEIs and natural sciences). The sample focuses on those papers the authors of which are ordered according to the contribution of the authors to the research.

(a) Normal papers

| HEIs, Normal papers | | Japan | China | Other Asia | Europe | US | Other, unknown |
|---|---|---|---|---|---|---|---|
| Japan | Young scholar (261) | 71.3% | 8.8% | 8.8% | 3.8% | 1.5% | 5.8% |
| | Senior scholar (457) | 88.8% | 3.1% | 2.8% | 2.4% | 1.1% | 1.8% |
| US | Young scholar (266) | 2.6% | 15.8% | 14.7% | 19.9% | 36.1% | 10.9% |
| | Senior scholar (209) | 4.8% | 7.7% | 17.2% | 13.9% | 45.5% | 11.0% |

(b) Highly cited papers

| HEIs, Highly cited papers | | Japan | China | Other Asia | Europe | US | Other, unknown |
|---|---|---|---|---|---|---|---|
| Japan | Young scholar (86) | 64.0% | 5.8% | 9.3% | 8.1% | 5.8% | 7.0% |
| | Senior scholar (138) | 84.8% | 3.6% | 0.7% | 4.4% | 2.9% | 3.6% |
| US | Young scholar (111) | 1.8% | 19.8% | 13.5% | 23.4% | 28.8% | 12.6% |
| | Senior scholar (77) | 0.0% | 3.9% | 13.0% | 14.3% | 58.4% | 10.4% |

*International co-authorship vs. Involvement of foreign born scholars*

Figures 4 (a) and (c) show the percentage of international co-authorship in Japanese and the US samples, respectively. We included the information of the number of countries involved in the co-authorship in the figures. Here, the country represents the country of organizations in which authors were affiliated. The data of affiliated country was retrieved from the WoS. The percentage of international co-authorship in normal papers, around one quarter, is similar between Japan and the US. The percentage shows remarkable increase in Japanese highly cited papers. It increases by around 20% points, while no significant increase is observed in the US.

Figures 4 (b) and (d) show the participation of foreign-born scientists in authors. As shown in the origin of birth of the first authors, there is a striking difference between Japanese and the US samples in the combination of origins. In the normal papers, foreign-born scientists are involved in more than 70% of research teams in the US, while in around 30% of research teams in Japan. Involvement of foreign scientists in research teams is more common in the highly cited papers compared to the normal papers. This characteristic is more evident in Japanese samples.

Table 2 summarizes the results. In Japanese samples, more than 80% of the domestic papers involve no foreign-born scientists in authors. In contrast, more than 90% of the internationally co-authored papers involve foreign-born scientists. These observation indicates that majority of foreign-born scientists observed in the Japanese survey were affiliated with the organizations outside of Japan.

In contrast, about 70% of domestic papers involve at least one foreign-born scientist in the US. The result means that the foreign-scientists counted here were affiliated with the organization in the US, clearly indicating “brain drain” to the US and the US’s large dependence on foreign talents.

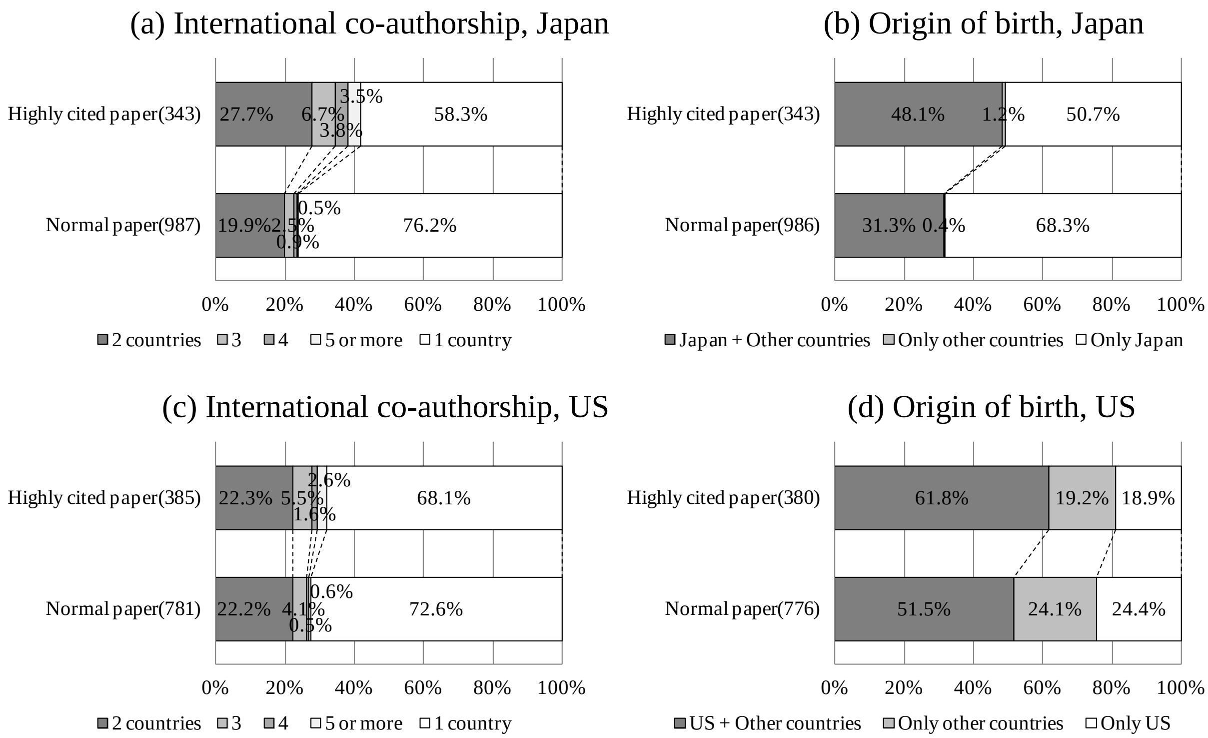



**Figure 4.** Diversity in origin of birth and international co-authorship.
Results of higher education institutions and natural sciences.

**Table 2.** Type of the authorship vs. Origin of birth. Results of higher education institutions and natural sciences.

| Japan | Origin of birth | | |
|---|---|---|---|
| | Only Japan | Only other countries | Japan + other countries |
| Domestic authorship | 86.1% | 0.1% | 13.8% |
| International authorship | 7.2% | 1.9% | 91.0% |

| US | Origin of birth | | |
|---|---|---|---|
| | Only US | Only other countries | US + other countries |
| Domestic authorship | 30.5% | 19.8% | 49.7% |
| International authorship | 2.7% | 29.3% | 68.0% |

## Diversity in the field of expertise in research team

Combination of knowledge between the fields of science is getting crucial in the knowledge creation. Recognition of the importance of inter-disciplinary or multi-disciplinary research in the context of national science and technology policy, e.g. nanotechnology, has been increasing in the past decade. Inter/multi-disciplinary research is becoming pervasive in science (Saka, Igami & Kuwahara, 2010).

In the scientists' survey, we collected information about the field of expertise of authors. Figures 5 (a) and (b) summarise the number of fields of science covered by research teams. It was found that the degree of diversity in terms of fields in the normal papers is similar in both counties (around 30%). There is a significant difference between Japan and the US in the highly cited papers. Research teams in the US involve authors from more diverse field of science (about 40% of research teams consist of two or more fields of expertise).

Figures 5 (c) and (d) show the collaboration pattern in research teams. Thickness of lines represents the occurrence of collaboration between two fields of science in the samples. The pattern of collaboration differs between Japan and the US. The collaboration between "computer science & mathematics" and "basic life sciences" is more frequent in the US. In contrast, higher frequency of collaboration between "engineering" and "materials science"; and "engineering" and "physics & space science" was observed in Japan.

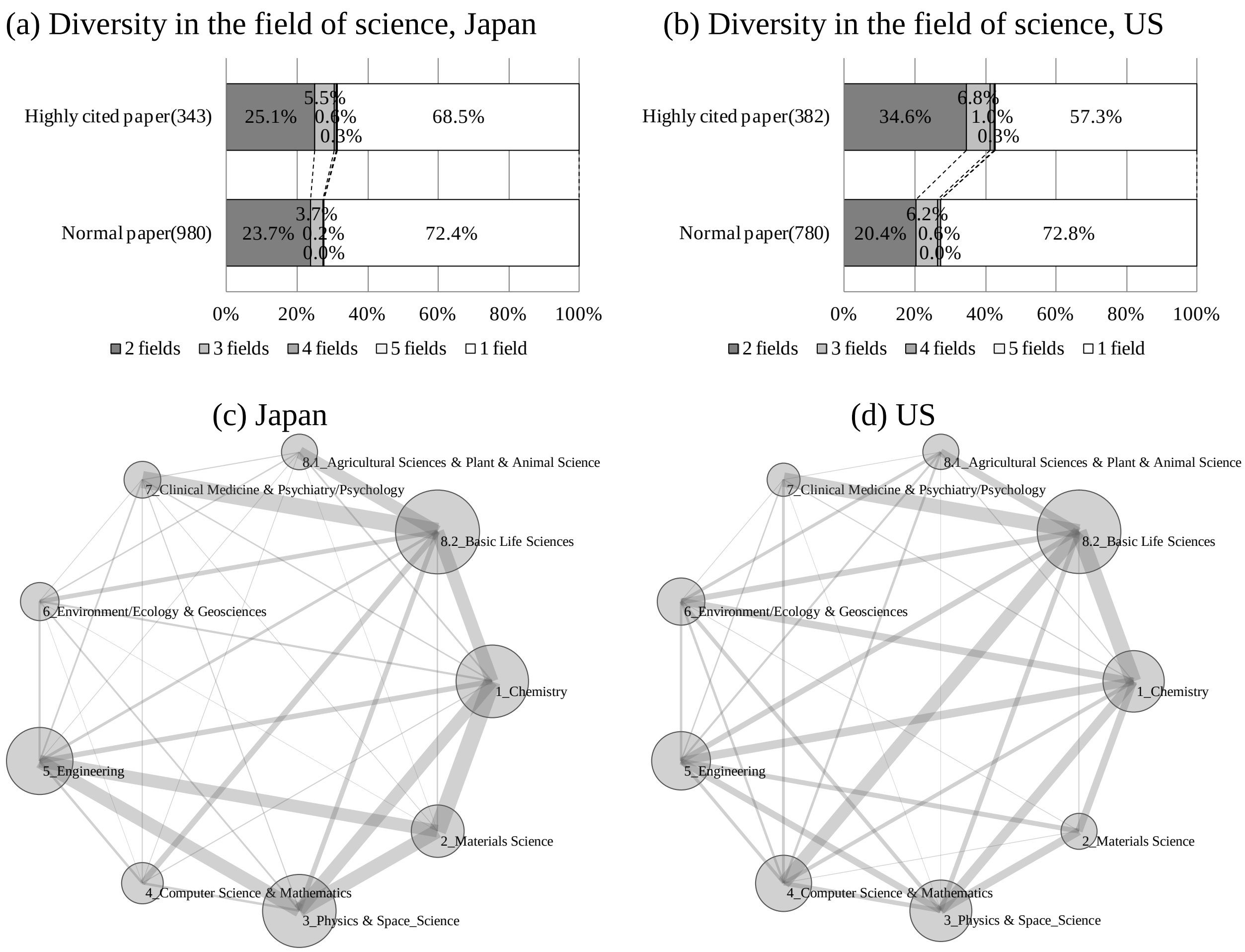



**Figure 5.** Diversity in the field of science in Japan (a) and in the US (b). Collaboration pattern in research teams in Japan (c) and in the US (d). Area of circles area shows the occurrence of the field in the collaboration.

## Summary and outline of the analytical work to be completed

This research in progress paper has reported the descriptive statistics regarding the involvement of young scholars in the knowledge creation and internationalization of research team based upon results of a large-scale survey of Japanese and US scientists. Major findings are as follow:

- Young scholars (students and postdoctoral fellows) are important contributors for research efforts in both countries. PhD students and postdoctoral fellows are often the first authors of top 1% highly cited papers. In the US, postdoctoral fellows are the first author on half of highly cited papers in life sciences. Involvement of young scholars is the smallest in Japanese physical sciences.
- The involvement of young foreign-born scholars is important in both countries. It accounts for more than 70% of the first authors of highly cited papers in the US and around one-third in Japan.
- The US teams are significantly more diversified in the origins of birth than the Japanese teams (80% of teams in the US involve scientists from more than one country vs. 50% in Japan for the highly cited papers). About 80% of domestic papers involve at least one foreign-born scientist in the US sample; it reflects the inflow of foreign-born scholars to the

US. In contrast, the majority of foreign-born scientists observed in the Japanese survey were affiliated with organizations outside of Japan.

- Research teams in the US involve authors from more diverse fields of science (about 40% of research teams consist of two or more fields of expertise in the highly cited papers). The collaboration between "computer science & mathematics" and "basic life sciences" is more frequent in the US.

Focusing on the relationship between research team characteristics and outcomes of research project such as citation counts of the focal paper, the number of papers yielded by the project, and the incidence of patent applications, we will attempt to identify impacts of research team characteristics on the knowledge creation process in science.

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