Research Report - APRC-FY2022-RR-05

Asia and Pacific Research Center

Research on Nurturing and Maintaining STI talents in South Korea

March 2024

Japan Science and Technology Agency

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This report is compiled as part of a research that surveyed and analyzed science and technology innovation policies, research and development trends, and associated economic and social circumstances in the Asia-Pacific region. It is being made public on the APRC website and portal site to enable wide use by policymakers, associated researchers, and people with a strong interest in collaborating with the Asia-Pacific region; please see the websites below for more details.

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Executive Summary

Currently, Asia and Pacific is one of the most remarkable regions in terms of rapid economic growth. It has also achieved an innovative progress of science and technology in a recent decade. South Korea has obtained high attention from global R&D community in its science and technology output. Japanese government is conducting countermeasures to attract highly skilled talents or STI talents from abroad, amid shrinking domestic production-age population.

Every five years South Korean government enacts a “Basic Plan for Science and Technology” as well as a “Basic Plan for supporting STI talents”. These plans, which are generally linked to the change of government, including goals and visions for science and technology, areas of science and technology to be focused on for the next five years, the image of STI talents to be fostered and secured, and strategies for achieving these goals.

This research aims to clarify South Korea’s policies and strategies on fostering and maintaining talents of science and technology and suggest possible implications for Japan’s scientific and technological prosperity. It firstly covers basic STI indicators and policies along with the necessary social backgrounds. It secondly shows main policies respectively: (1) nurturing domestic STI talents in South Korea; (2) promoting STI talents to study abroad; (3) inviting high revel STI talents to South Korea; (4) supporting foreign students. It also focuses on inviting foreign students to South Korea since they are expected to be human resources in R&D for the future.

The following four points are characters of South Korea’s STI talents strategies.

First, South Korea is focusing on gifted education, and putting efforts into improving the school environment and infrastructure. The government also provides extensive support for young talents until they are ready for their careers. In addition to increasing the number of support programs for post-doctoral researchers, the government is developing various support programs for doctoral graduates so that they can continue their research even if they can’t immediately find a job after graduation. In addition, there is a well-developed platform focused on STI talents and the link between s science and culture.

Lessons for Japan are summarized in the five points:

The first is continuously and stably expand investment in science and technology, R&D projects, and human resource development.

The second point is the development of universities specializing in science and technology.

Third, the shortage of doctoral and postdoctoral positions is being solved through the development of practical STI talents.

The fourth point is the expansion of support for female researchers and the increase in the percentage of female researchers.

Fifth, the government is strengthening support for excellent overseas human resources and foreign students.

South Korea is making continuous and stable investments in science and technology, and is providing generous support for young researchers, regardless of whether they are in master’s or doctoral programs. In addition, to support female researchers, South Korea has established a “Basic Plan to Support the Development of Female Scientists and Engineers” every five years and focusing on attracting foreign students. As a result of such coherent policy efforts, South Korea has made incredible progress. We hope that this report will be useful one for Japan’s policy for STI talents.

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1 Overview of the Survey

1.1 Background and Purpose of the Survey

The Asia-Pacific region (including both Asia and Oceania as listed in the Ministry of Foreign Affairs Organization Order) accounts for about 60% of the world's population and approximately 30% to 40% of the world's GDP and research and development expenditures. It is an increasingly large influence on global politics, economy, and society. Especially in economic terms, the region's share in the world's GDP (nominal)[1] was 34.4% in 2021, a significant increase from 18.8% forty years ago in 1980, and 25.5% twenty years ago in 2000. This represents approximately an 80% increase from forty years ago and about a 30% increase from twenty years ago. It is, therefore, rapidly increasing in significance and leading the global economy as a center of growth.

The rapid development of the Asia-Pacific region can largely be attributed to the successful advancement in economic activities throughout its countries and regions and its foundation of R&D activities through the cultivating and securing of STI talent. Enhancing strategies for developing and securing STI talents is a common policy seen across these regions. However, especially in China (global GDP share has increased about sevenfold over 40 years) and in South Korea and Singapore (global GDP share has increased three to fourfold over 40 years), policies have been implemented to (1) strengthen the domestic development of advanced talent through the promotion of higher education institutions, (2) enhance the training of their students and researchers abroad as international students, etc., and (3) attract outstanding talents from overseas (including their own countries' citizens) as researchers and foreign students. These development could not have been achieved without investment- and effective strategies for nurturing and supporting STI talent.

From Japan's perspective, considering the long-term decline in its share of global GDP and subsequent stagnation, and the recent decrease in its share of total scientific papers and highly cited papers, it is essential to understand how rapidly developing major countries within the Asia-Pacific region are retaining and developing STI talent, and draw insights from their efforts.

Furthermore, when advancing scientific and technological cooperation with these countries, understanding their strategies will be effective for promoting smooth collaboration.

Based on the above situation, a survey on the development and retention of STI talent, which forms the foundation of scientific and technological strength in the Asia-Pacific, was conducted with the following goals:

(1) To assess the policies and strategies related to the development and retention of STI talent in major countries within the Asia-Pacific region, from the perspective of maintaining and improving Japan's research capabilities, and to identify matters that can serve as references for advancing the development and retention of this talent in Japan.

(2) To assess the policies and strategies related to the development and retention of STI talent in major countries within the Asia-Pacific region, and to use this information as a basis for promoting scientific and technological cooperation between Japan and these major countries in the Asia-Pacific region.

1 Based on the materials from the 18th Asia-Pacific Study Group "Asia and Japan in a World of Change" (held on January 19, 2023 / Lecturer: Takashi Shiraishi). https://spap.jst.go.jp/event/apstudy018.html

1.2 Survey Method and Compilation

This paper focuses on South Korea, which has shown remarkable economic development and shares many similarities with Japan but has not been systematically surveyed. From the perspective of strengthening Japan's scientific and technological capabilities - and especially research capabilities - the targeted STI talent was primarily researchers, but also included personnel supporting scientific and technological activities in general, and students and international students (both foreign students enrolled in higher education institutions in the country and students from the country enrolled in higher education institutions in other regions) as needed. The impact of the COVID-19 pandemic since 2020 is also discussed, particularly in regard to international student numbers.

Additionally, this survey aims to elucidate several key matters:

Firstly, an assessment of research capabilities will be conducted to attain a comprehensive understanding of the state of science and technology within South Korea. Metrics such as researcher numbers, numbers of publications and highly cited papers, and the ratio of international co-authored papers, alongside patent counts, will be analyzed not just on a numerical basis but also to contextualize international standing through national rankings or comparisons with other countries.

Next, its fundamental policies and principal measures for fostering STI talent will be outlined.

This includes the introduction of policy documents that detail foundational strategies, along with their primary content, supplemented by necessary background information.

The principal measures for nurturing STI talent include domestic training of researchers, training abroad, promotion of female researchers, recruitment of foreign researchers, and support for international students.

Furthermore, based on the findings of the above investigation, this paper presents aspects of the subject country's science and technology talent development and retention that Japan should reference.

The execution of this survey across the aforementioned major countries, along with the compilation of evaluations and characteristics of developing and securing these talents—and insights for Japan—will be approached with an understanding of the current landscape and challenges in nurturing and securing STI talent in Japan, as described in the subsequent section.

1.3 Overview and Challenges of Nurturing and Securing STI Talent in Japan and Considerations for Surveying Major Countries

To conduct this survey effectively and to propose actionable insights for Japan, assessing the current situation surrounding developing and securing STI talent in Japan from an international perspective and pinpointing its challenges is crucial. The international benchmarking relies on data from the "Science and Technology Indicators 2022,"[2] except for instances explicitly cited from other sources. The challenges in developing and securing STI talent in Japan are organized around the Sixth Science, Technology, and Innovation Basic Plan.[3]

2 "Science and Technology Indicators 2022," NISTEP RESEARCH MATERIAL, No. 318, National Institute of Science and Technology Policy, Ministry of Education, Culture, Sports, Science and Technology

3 "The Sixth Science, Technology, and Innovation Basic Plan" was adopted by the Cabinet on March 26, 2021.

1.3.1 Overview of Developing and Securing STI Talent in Japan

(1) General Overview

Enhancing Japan's scientific and technological capabilities necessitates an initial review of the country's scientific and technological endeavors as compared from an international standpoint. Here, this report examines whether the outcomes of scientific and technological activities, such as the number of papers published and the number of highly cited papers, correspond to the investment in these activities, including research and development expenditures and the number of researchers.

(1.1) Indicators of Research Capability: Number of Papers, Number of Highly Cited Papers

In terms of research outputs, represented by the number of publications and highly cited papers, Japan has observed a decline in its global rank. Firstly, according to the Science and Technology Indicators 2022, its number of publications (fractional count) fell from 4th place worldwide in the previous year, to 5th place. Secondly, even amongst the Top 10% of Number of Papers (corrected fractional count) it has dropped from 10th place in the previous year to 12th. Both its rankings and its share in the global total have significantly declined over the past 20 years.

(1.2) Indicators of Technological Capability: Patent Application Volume

In terms of patent application volume (patent families), which serve as indicators of scientific and technological output and technological prowess, Japan has maintained its leading position, ranking 1st compared to the previous year. The country's share of the global total in this area has remained consistently high and stable over the past two decades.

(1.3) Research and Development Investment and Numbers of Researchers

Research and development expenditure, indicative of investment in scientific and technological activities, positions Japan 3rd globally, the same as last year. When considering only university-based research and development spending, Japan holds the 4th position, which is also unchanged from the previous year. Furthermore, in relation to the researcher numbers, Japan's global ranking remains unchanged at 3rd place. Japan is also estimated to rank 4th (unchanged since the previous year) when universities are considered in isolation. This adjustment is based on the projection that the number of researchers in American universities, although not detailed in the "Science and Technology Indicators 2022," is likely higher than that of Japan, suggesting a shift in Japan’s ranking from 3rd to 4th when excluding the United States

(1.4) Evaluation

Regarding Japan's research capabilities, as evidenced by the metrics of paper publication and highly cited papers, there has been a sustained decline. This trend is particularly concerning given Japan's ranking: 3rd in GDP, 3rd in R&D expenditures, and 3rd in the number of researchers as of 2021. These rankings highlight significant areas for improvement. Particularly in relation to the cultivation and retention of research talent, as will be discussed later, the number of research papers has a strong correlation with the number of researchers in universities and similar institutions. Ensuring a sufficient number of researchers in these institutions is an urgent issue. In addition, Japan’s diminishing global share of highly cited papers signals a worrying trend in the quality of research outputs. Enhancing the quality typically involves increasing the rate of internationally co-authored papers, which necessitates further efforts to facilitate mobility among researchers. Future sections will detail that the proportion of international co-authorship in research is strongly linked with the combined numbers of foreign students in domestic higher education and domestic students studying abroad. This suggests that fostering intellectual exchanges, not only among researchers but also among students, can boost international co-authorship. Therefore, a more concerted effort in this direction is warranted.

Conversely, in assessing Japan's technological capabilities, while an in-depth analysis of technological trade dynamics would be ideal, examining its performance in terms of patent applications (patent families) reveals that they are impressively high.

(2) Current Status and Transitions in the Number of Researchers in Japan

The current status and transitions in the number of researchers in Japan are shown below.

- The total number of researchers in Japan reached 670,000 in 2006 and has been mostly unchanged or slightly increasing since.
- In 2021, there were 690,000 researchers (FTE value), placing Japan 3rd after China and the United States.
- Since 2000, the number of researchers in other major countries (China, the United States, Germany, South Korea, etc.) has been steadily increasing, and the relative ratio of Japan's researchers compared to these countries has been declining. Notably, among these countries, Japan demonstrates the lowest proportion of researchers employed in universities and research institutions—approximately 25%, positioning it fifth in absolute numbers behind China, the United States, the United Kingdom, and Germany.

A comparison among the top five countries by number of research papers—China, the United States, the UK, Germany, and Japan—shows a direct correlation between research output and the number of researchers at universities and research institutions, excluding those in corporate sectors.

This situation underscores the urgent need to secure a sufficient number of researchers at universities and similar institutions.

Table 1-1 Number of Papers and Number of Researchers in Major Countries

Country	Number of Papers (Ten thousand)	Top 10% Number of Papers (Ten thousand)	Total Number of Researchers (Ten thousand)	Number of Researchers at Universities and Research Institutions (Ten thousand)
China	26.8(1)	33.4(1)	228.1(1)	94.7(1)
United States	22.9(2)	31.8(2)	158.6(2)	43.9(2)
United Kingdom	7.0(3)	11.4(3)	31.6(5)	18.4(3)
Germany	6.6(4)	9.0(4)	45.2(4)	18.0(4)
Japan	5.0(5)	4.0(12)	69.0(3)	17.5(5)

Source: NISTEP Science and Technology Indicators 2022

Note 1: The number of papers and top 10% number of papers are based on the whole number count for the years 2018-2020.
Note 2: The number of researchers at universities and research institutions excludes researchers at companies.
Note 3: The total number of researchers and the number of researchers at universities and research institutions are for 2019 for the United States and the UK, 2020 for China and Germany, and 2021 for Japan.

(3) Domestic Training of Researchers

As indicators of domestic training of researchers in Japan, the number of PhD holders and the number of new PhD graduates are shown below.

- The number of PhD holders among Japanese researchers was 182,000 in 2021, about 1/4 of all researchers. Of these, the majority, 157,000, were affiliated with universities and research institutions, excluding corporations.
- The number of new PhD graduates has been mostly unchanged since the fiscal year 2000, with 15,000 graduates in the fiscal year 2019. Internationally, in fiscal year 2019, this number was lower than the United States which had 92,000 graduates (fiscal year 2018), China with 61,000, Germany with 29,000, the United Kingdom with 24,000, and South Korea with 15,000. Although it was higher than France (11,000), it is still a low number of graduates. By comparison, compared to the fiscal year 2000, numbers of PhD Graduates om South Korea, China, the United States, and the UK have more than doubled, while Japan, Germany, and France have remained mostly unchanged.

This indicates that increasing the number of new PhD graduates is an urgent issue in Japan.

(4) Overseas Training of Researchers

As indicators of domestic training of Japanese researchers, the number of Japanese students studying abroad, the number of Japanese-born PhD holders in the United States, and international mobility seen in the affiliations of Japanese researchers when writing scientific papers are shown below.

- 107,000 Japanese students were studying abroad[4] in fiscal year 2019, prior to the COVID-19 pandemic, approximately triple the 36,000 in fiscal year 2009.
- Meanwhile, the number of Japanese-born PhD holders in the United States was 114 in 2020 (129 in 2019), halving over 10 years from 236 in 2010[5], while the number of PhD holders from other countries and regions, excluding the US, increased by 36% (13,636 to 18,482). Japan, therefore, had the largest decrease among major countries at 52%.
- Examining the bilateral movement of scientific paper authors[6], the international mobility of Japanese researchers (scientific paper authors) is extremely low compared to other countries, especially advanced Western countries, with the number per researcher or GDP comparable to China and South Korea.

Hence, from the perspective of increasing the number of international co-authored papers and improving the quality of research and research papers, it is necessary to support individuals to obtain degrees (such as PhD) abroad and further develop the circulation of intellectual expertise.

(5) Invitations to Foreign Researchers

The number of foreign researchers accepted from overseas in Japan is shown below.

- The number of researchers accepted from overseas in Japan in fiscal year 2019 was 35,228[7] (of which, short-term stays of less than one month were 21,948 (slightly decreased from the previous year due to the impact of the

4 "Survey Results on Japanese Students Studying Abroad in Fiscal Year 2019," Japan Student Services Organization (JASSO), March 2021

5 “Science and Engineering Indicators, Survey of Earned Doctorates,” NSF

6 "Promotion of International Circulation of Intellectual Expertise," Science and Technology Policy Bureau, Ministry of Education, Culture, Sports, Science and Technology, June 9, 2021

7 "Strategy on International Expansion of Science and Technology," Council for Science, Technology and Innovation, International Strategy Committee, March 30, 2022

COVID-19 pandemic) and mid- to long-term over one month was 13,280), and both short-term and mid- to long-term invited researcher numbers have remained largely unchanged since around the year 2000.

Steadily increasing invitations to talented foreign researchers not only advances joint research at the time of acceptance but also leads to long-term stays and permanent residency amongst outstanding researchers. Considering this, preparing an environment that also accepts researchers' families is an issue that requires ongoing efforts.

(6) Support for Foreign Students in Japan

The number of foreign students in Japan is shown below[8].

- The number of foreign students in Japan (including students enrolled in higher education institutions as well as Japanese language education institutions) was 312,000 in fiscal year 2019, which was less affected by the COVID-19 pandemic, more than double from 132,000 in fiscal year 2009 (however, at that time, students enrolled in "Japanese language education institutions" were not included).
- In fiscal years 2020 and 2021, due to the strengthening of border control measures against the COVID-19 pandemic, the entry of foreign students was mostly not permitted, except for some government-sponsored students, resulting in a decrease to 280,000 and 242,000 respectively for two consecutive years.

In addition, as shown in the following table, an international ranking of the sum of the proportion of foreign students enrolled in higher education institutions in major countries and the proportion of students from these countries studying abroad shows a very strong correlation with the international ranking of the proportion of internationally co-authored papers. Various factors determine the proportion of internationally co-authored papers, but enhancing the international mobility of students will likely be effective in increasing this proportion, hence securing both Japanese students studying abroad and foreign students in Japan is important for improving research capabilities.

8 "Survey Results on the Status of Foreign Students Enrolled in Japanese Schools in Fiscal Year 2021," Japan Student Services Organization, March 2022

Table 1-2 Indicators of student mobility and the proportion of internationally co-authored papers in major countries

A: The proportion of foreign students among those enrolled in higher education institutions in the country
B: The proportion of students from the country enrolled in higher education institutions abroad
C: A+B
D: The proportion of internationally co-authored papers

Country	A (Proportion of foreign students %)	B (Proportion of Korean students studying abroad %)	C (%)	D (%)
United Kingdom	19	2	21	71
France	9	4	13	66
Germany	10	4	14	62
United States	5	1	6	47
Japan	5	1	6	36
Korea	3	3	6	32
China	0	2	2	26

Source: OECD education at a glance 2021

1.3.2 Challenges in Developing and Securing STI Talent in Japan

As challenges in developing and securing science and technology personnel in Japan, the Sixth Science, Technology, and Innovation Basic Plan[9] (hereinafter referred to as "the 6th Basic Plan" in this chapter) presents the following:

In the 6th Basic Plan, three major goals are set for the realization of Society 5.0, but from the perspective of developing and securing researchers in particular, the plan presents the two following major goals:

(1) Continuously creating knowledge that is both diverse and outstanding, regaining world-leading research capabilities

(2) Developing talent who pursue various forms of happiness and take on challenges to transform the whole of Japan into Society 5.0

In tackling these major goals, specific measures are provided for the following challenges surrounding developing and securing researchers (categories only).

(1) Regaining world-leading research capabilities

(1.1) Reconstructing an environment for diverse and excellent research

- Improvement of conditions and expansion of career paths for doctoral students
- Creating an environment where young researchers can thrive in universities and other institutions
- Promotion of activities by female researchers
- Promotion of basic and academic research

[9] Same as footnote 3.

- Promotion of international joint research and international circulation of intellectual talent
- Securing research time
- Promotion of humanities and social sciences and producing integrated knowledge
- Integrated reform of competitive research funding systems

(1.2) Promoting university reform and expanding functions for strategic management

- Transforming national university corporations into true management entities
- Deregulation to support strategic management
- Creation of a university fund on the scale of 10 trillion yen
- Diversification of public funds and governance that supports the foundation of universities
- Strengthening the function and financial foundation of national research and development corporations

(2) In addition, developing talent for the transition to Society 5.0

(2.1) Strengthening the development of inquiry skills through the promotion of STEAM education

(2.2) Promoting DX in the field of education

(2.3) Promoting mobility amongst talent and enhancing learning for career changes and career advancement

(2.4) Providing diverse curricula and programs in universities and colleges of technology

In 1.3.1, the challenges in nurturing and securing science and technology personnel in Japan were presented through a comparison of data on the scientific and technological capabilities with major countries. However, these are all included in the challenges and specific measures presented in the aforementioned 6th Basic Plan.

An overview and challenges of developing and securing STI talent in Japan were presented by comparing data on scientific and technological capabilities with major countries, and the major goals and specific measures of Japan's basic policy, the 6th Basic Plan, were shown. The next chapter onwards is a survey of South Korea which takes into account the situation in Japan as described above. It explicitly evaluates and describes the characteristics of developing and securing STI talent, and introduces matters considered to be of reference to Japan's challenges, along with specific measures, are investigated.

2 Overview of South Korea's Research Strengths

Before discussing South Korea's strategy for developing and securing STI talent, it is important to understand the global position and international competitiveness of South Korea's science and technology in the increasingly competitive global landscape. Therefore, this chapter will first clarify South Korea's international standing and research capabilities using various indicators[10].

2.1 Research and Development Expenditure

South Korea's research and development expenditure increased from 1.2 billion won (approximately 120 million yen, with 10 won being converted to 1 yen for the purposes of this report) in 1963 to 102.1352 trillion won in 2021, ranking fifth worldwide[11]. Its research and development expenditure has been increasing annually, with a 9.7% increase in 2021 compared to the previous year. While there is a perception that a large proportion of research and development expenditure in South Korea comes from corporations, even when comparing only research and development expenditure from the government and universities, South Korea ranks sixth worldwide[12].

Furthermore, its ratio of research and development expenditure to GDP has been around 4%[13] since 2014, but it reached 4.93% in 2021, marking it as the **second highest among OECD member countries**[14]**.**

In 2021, South Korea spent 100 trillion won in research and development expenditure for the first time, a clear demonstration of its continued investment in research and development and science and technology development, considering the country's size and population.

10 Unless specifically mentioned, the indicators used in this chapter are science and technology statistics from NTIS.

11 It ranks fifth after the United States, China, Japan, and Germany.

12 Excluding corporate research and development expenditure, it ranks sixth after the United States, China, Japan, Germany, and France.

13 From 2014 to 2020, its figures were 4.08%, 3.98%, 3.99%, 4.29%, 4.52%, 4.63%, and 4.81%, respectively.

14 Israel ranked first at 5.56%. South Korea has maintained the second position since 2017.

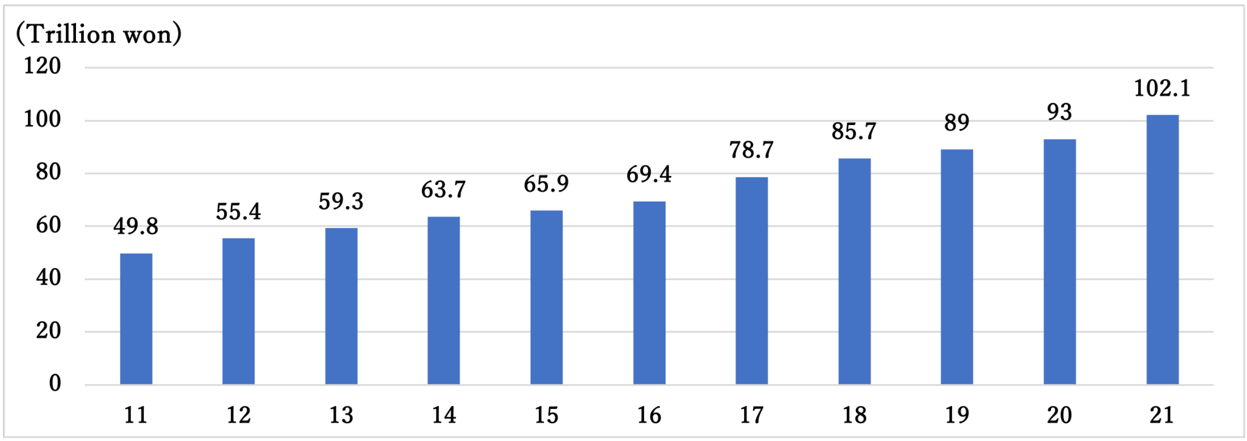


Figure 2-1 South Korea's Research and Development Expenditure

Source: NTIS "Science and Technology Statistics"

2.2 Number of Researchers & Proportion of Female Researchers

The total number of researchers in South Korea has continued to increase by about 20,000 people each year since around 2000. In 2021, its total number of researchers was 586,666, with an FTE[15] value of 470,728. Its **total number of researchers,** like research and development expenditure, was **fifth worldwide. Its number of FTE researchers** was fifth until 2020 but rose to **fourth** in 2021, surpassing Germany and only being exceeded by China, the United States, and Japan.

In 2021, Korea's FTE researcher numbers per 1,000 people in the workforce were 16.7, and 9.1 per 1,000 people in its population. Both of these results are the **highest in the world.** This means that South Korea has the highest number of researchers per capita. Researchers are fundamental to the development of science and technology. Therefore, securing a large number of researchers helps contribute to strengthening science and technology.

Its number of female researchers has also been increasing, from 70,993 in 2012 to 130,055 in 2021. Its proportion of female researchers has also increased within the total number, from 17.7% in 2012 to 22.2% in 2021.

Moreover, its number of PhD holders in science and engineering has been increasing annually, albeit slowly. The number of PhD recipients, which was around 5,000 per year in 2012, exceeded 7,000 in 2021, significantly contributing to scientific and technological research.

Notably, its numbers of engineers, considered as important as researchers in the field of science and technology, are also significant. According to the NTIS's science and technology statistics, South Korea had more than 100,000 engineers in 2015 and more than 160,000 in 2021. According to the high-level engineer supply ranking by the International Institute for Management Development (IMD) in Switzerland, South Korea rose from 34th place in 2016 to 25th place in 2020.

15 FTE (full-time equivalent): A conversion of working hours (including part-time work) converted to numbers of full-time (dedicated, regular) employees.

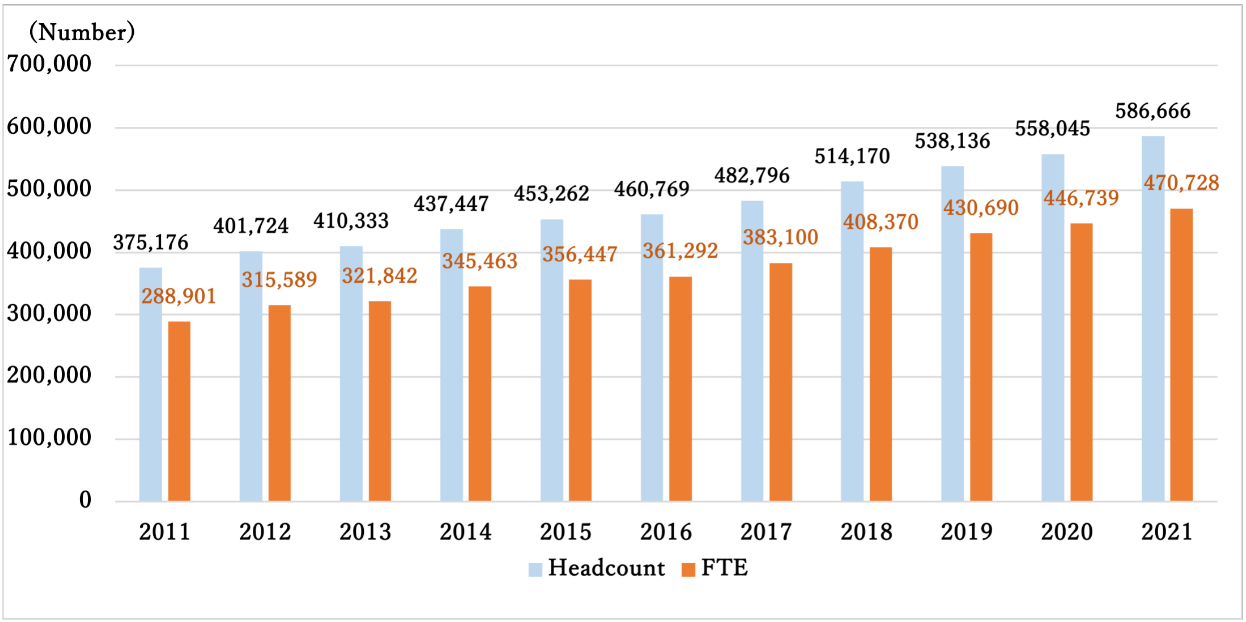


Figure 2-2 Transitions in the Number of Researchers in South Korea

Source: NTIS "Science and Technology Statistics"

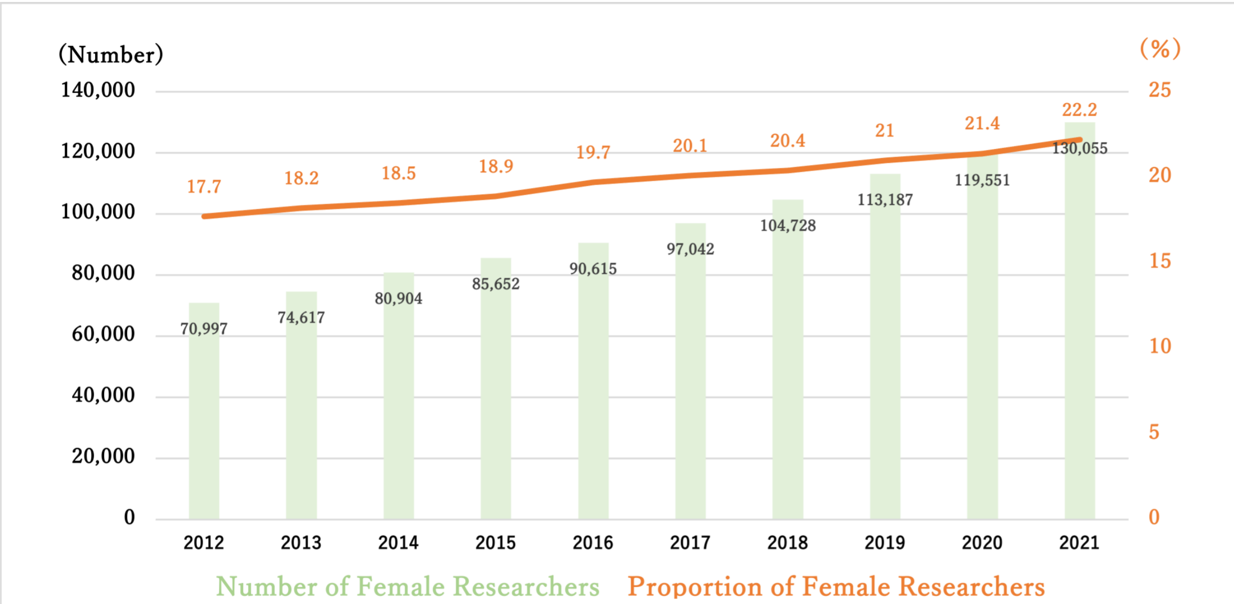


Figure 2-3 Transitions in the Number and Proportion of Female Researchers in South Korea

Source: NTIS "Science and Technology Statistics"

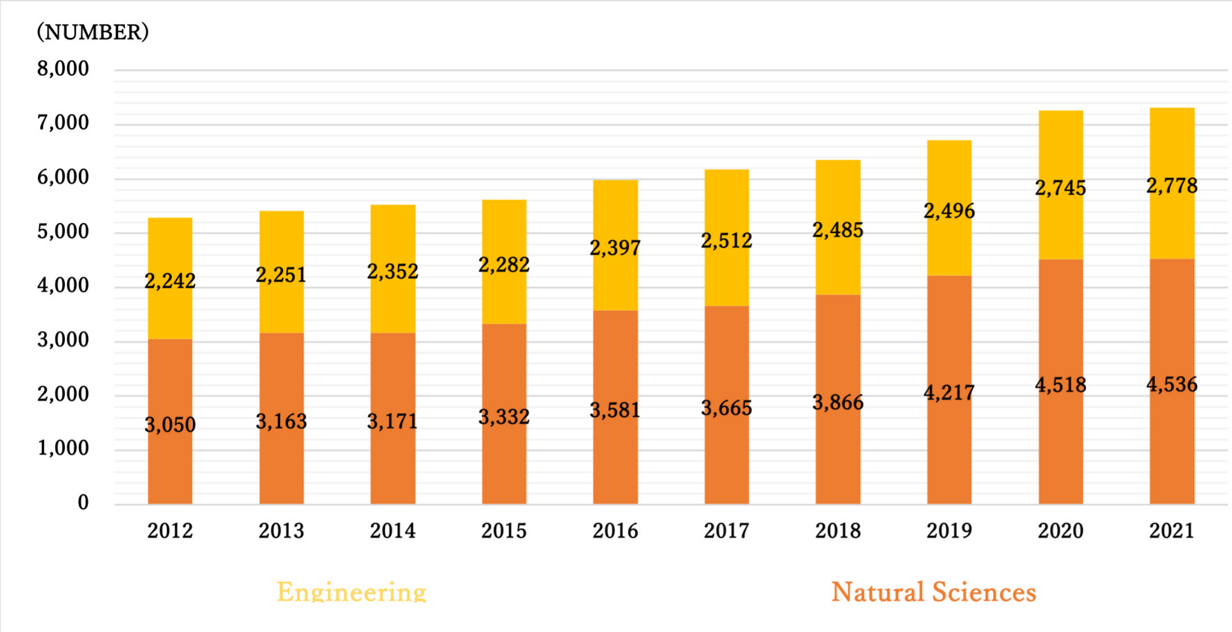
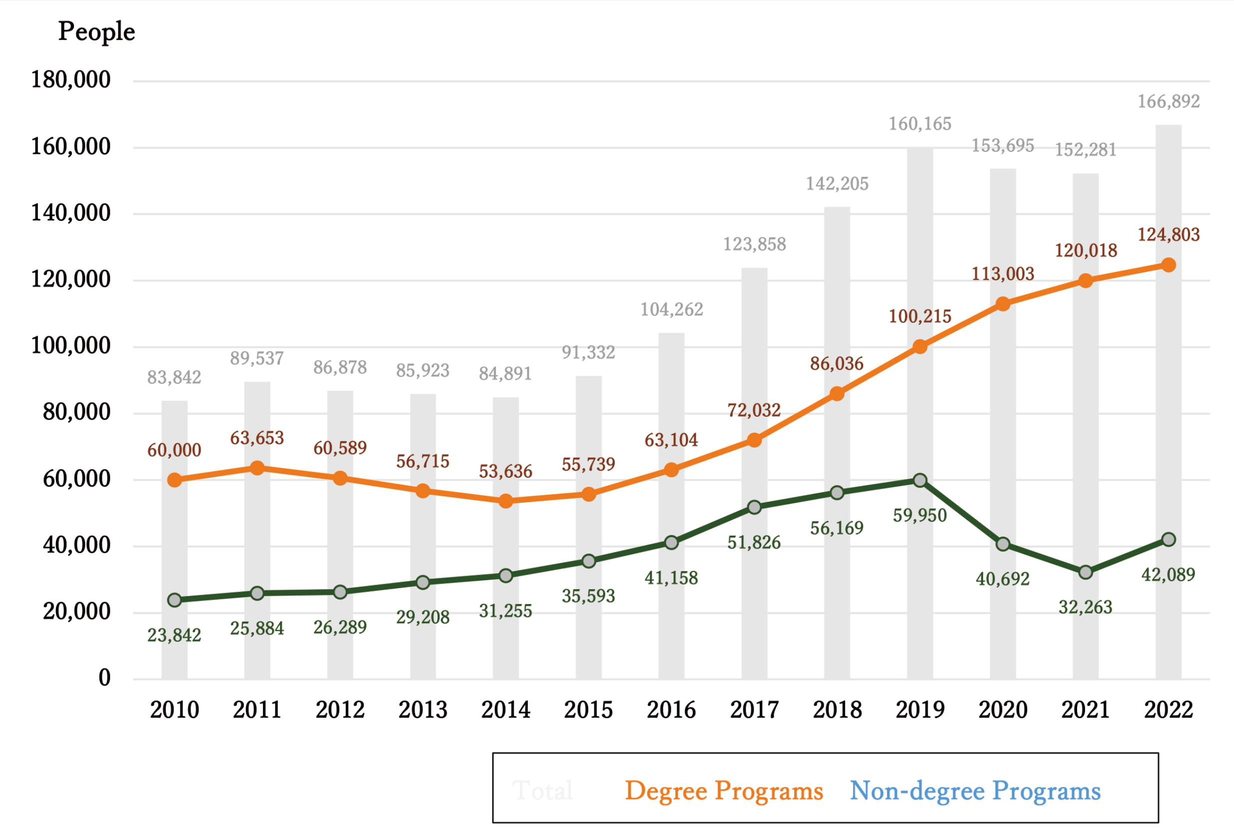


Figure 2-4 Number of Doctorates in Science and Engineering in South Korea

Source: Korean Ministry of Education "Annual Report on Education Statistics"

2.3 Number of International Students & Foreign Talent

The number of international students not only serves as an indicator of a country's global competitiveness and educational level but also represents a valuable presence for strengthening networks with other countries. **The number of foreign students staying in South Korea, both undergraduate and graduate, has been on an upward trend.** This indicates that many international students see South Korea as an attractive country. However, the number of South Koreans studying abroad is showing a decreasing trend. This can be interpreted as a result of improved education levels and increased research opportunities within South Korea, but there are concerns about whether this will negatively affect its future research capability.



Note: Degree programs include individuals enrolled in junior colleges or four-year universities to obtain a bachelor's degree, as well as individuals enrolled in graduate schools to obtain master's or doctoral degrees. Non-degree programs include language trainees, exchange students, and visiting trainees who do not aim to obtain a degree.

Figure 2-5 Transitions in the Number of International Students in South Korea

Source: Korean Basic Education Statistics 2022

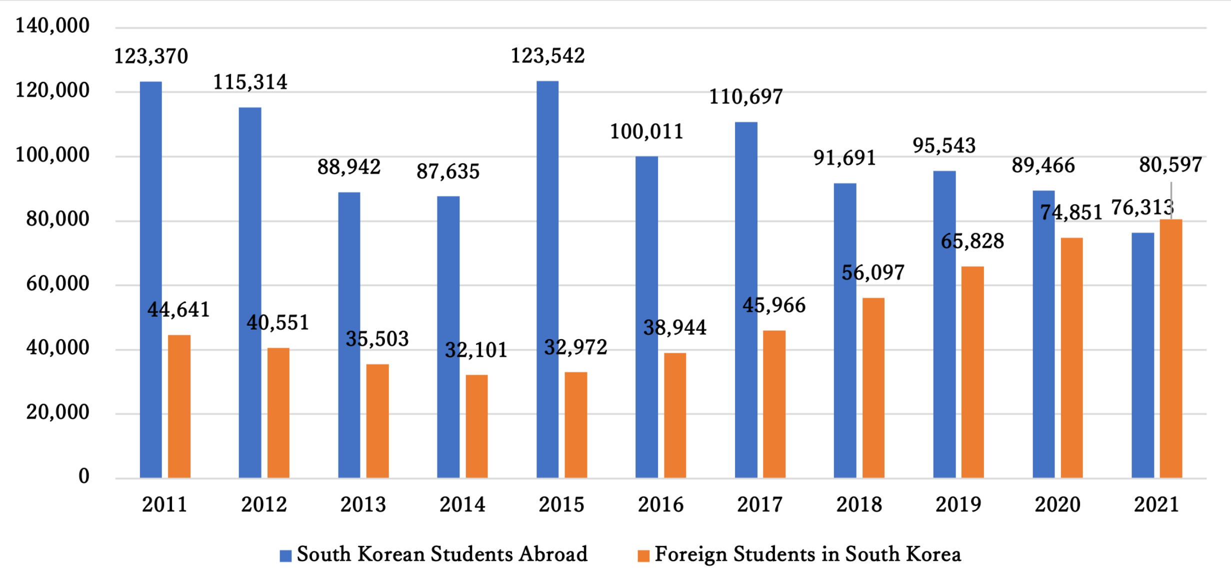


Figure 2-6 Number of South Korean Students Abroad & Foreign Students in South Korea (Undergraduate)

Source: NTIS "Science and Technology Statistics"

During the COVID-19 pandemic, when many countries struggled with decreased numbers of international students, South Korea continued to see an increase in students enrolled in degree programs.

Column: How did international student numbers in South Korea change before and after COVID-19?

In summary, **the number of international students in non-degree programs temporarily decreased due to the impact of COVID-19 but has shown an increasing trend again from 2022. The number of students in degree programs continued to increase even during the pandemic. The reasons for the steady number of international students include the effects of immigration policies, but various measures implemented through public-private cooperation are also believed to have contributed.**

According to the Korean Basic Education Statistics 2022[16],

- **In 2022, there was a total of 166,892 international students, an increase of 14,611 (9.6%) from the previous year.** International students accounted for 4% of the total enrollment in higher education institutions (3,117,540).
- The number of international students aiming for a degree was 124,803 (74.8%), an increase of 4,785 (4%) from the previous year, while those enrolled in nondegree programs were 42,089 (25.2%), an increase of 9,826 (30.5%) compared to the previous year.
- Notably, **even during the pandemic, the number of international students enrolled in degree programs continued to increase.**

Among international students, **Chinese students were the most numerous, totaling 67,439, accounting for 40.4% of all international students.** This represents an increase of 0.1% (91 students) from the previous year. Following China, there were 37,940 Vietnamese students (22.7%), 8,608 Uzbekistani students (5.2%), 7,348 Mongolian students (4.4%), and 5,733 Japanese students (3.4%), **with students from Asia (excluding Korea and North Korea) accounting for 88.3% of all international students.**

- While Chinese students remain the largest group, their proportion has significantly decreased compared to when they comprised 71% of all international students in 2010. For the first time in 2018, their proportion fell below 50% (48.2%), and by 2022 it had dropped to 40.4%.
- **Regardless of degree or nondegree programs, the increase in Vietnamese international students is remarkable.** Vietnamese students, who made up only 2.3% of all international students in 2010, increased to 22.7% by 2022. For degree programs, there was a significant increase from 2018, surpassing 10,000 in 2019, and exceeding 20,000 in 2021. In nondegree programs, they became the largest group in 2018, surpassing China and maintaining more than 10,000 students.

16 Full text: https://www.korea.kr/docViewer/skin/doc.html?fn=196938330&rs=/docViewer/result/2022.08/31/196938330

- **After Vietnam, another country with a notable increase in international students is Uzbekistan.** In 2010, there were only 427 students from Uzbekistan, accounting for 0.5% of all international students, but this percentage began to exceed 1% in 2015, reaching 2.2% in 2017, 3.9% in 2018, and 5.2% in 2022. **A characteristic of Uzbekistani international students is that most of them (8,249 out of 8,608) have come to South Korea with the purpose of obtaining a degree.**
- The number of Mongolian students fluctuated at around 3,000 from 2010 to 2015, but exceeded 4,000 in 2016, and surpassed 7,000 in 2022. The number of Japanese students in South Korea is also on an increasing trend, though the variation is not significant.
- **Among nondegree international students, there are notable increases amongst those from France.** From merely 360 in 2010, the number of French nondegree seeking students surpassed 1,000 in 2017, and increased to 2,247 by 2022, accounting for 5.3% of all nondegree international students.

Chart: Changes in the proportion of international students by country of origin before and after the pandemic

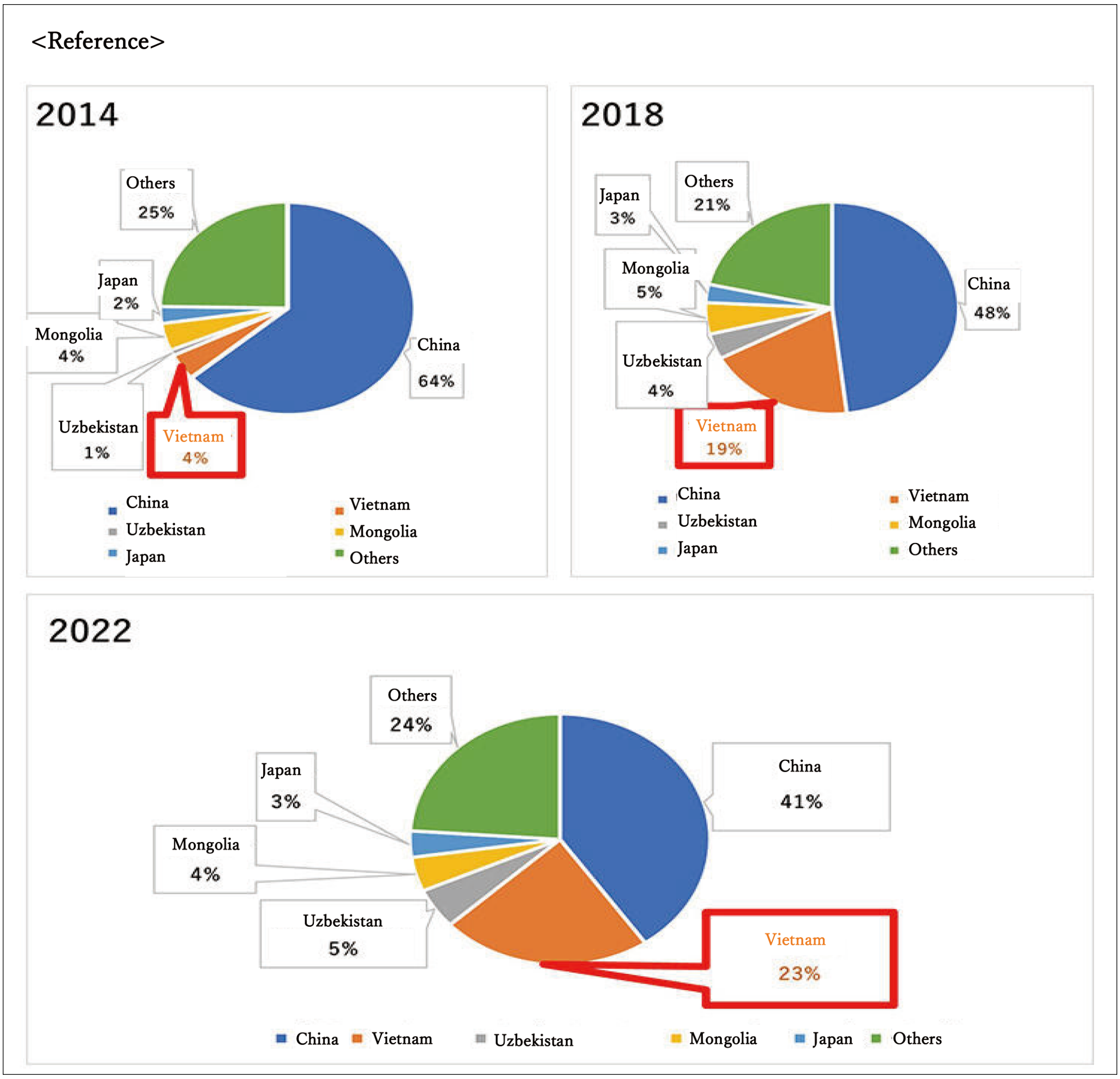


Table: Transitions in international student numbers by country of origin

表　出身国別留学生数の推移

Fiscal Year	Total	China	Vietnam	Uzbekistan	Mongolia	Japan	Others
2010	83,842	59,490	1,919	427	3,335	4,090	14,581
2011	89,537	60,935	2,332	521	3,700	4,645	17,040
2012	86,878	57,399	2,458	546	3,799	4,172	18,504
2013	85,923	52,317	3,013	628	3,904	4,503	21,558
2014	84,891	50,336	3,181	754	3,126	3,958	23,536
2015	91,332	54,214	4,451	1,066	3,138	3,492	24,971
2016	104,262	60,136	7,459	1,588	4,456	3,676	26,947
2017	123,858	68,184	14,614	2,716	5,384	3,828	29,132
2018	142,205	68,537	27,061	5,496	6,768	3,977	30,366
2019	160,165	71,067	37,426	7,492	7,381	4,392	32,407
2020	153,695	67,030	38,337	9,104	6,842	3,174	29,208
2021	152,281	67,348	35,843	8,242	6,028	3,818	31,002
2022	166,892	67,439	37,940	8,608	7,348	5,733	39,824

Table: Transitions in international student numbers in degree programs by country of origin

Fiscal Year	Total	China	Vietnam	Uzbekistan	Mongolia	Japan	Others
2010	60,000	45,944	1,667	343	2,196	1,350	8,500
2011	63,653	47,725	1,940	387	2,515	1,430	9,656
2012	60,589	43,961	1,889	384	2,631	1,347	10,387
2013	56,715	38,394	2,153	419	2,490	1,367	11,892
2014	53,636	34,482	2,148	481	2,236	1,416	12,873
2015	55,739	34,887	2,579	707	2,145	1,461	13,960
2016	63,104	38,958	3,466	1,083	2,279	1,568	15,750
2017	72,032	44,606	4,698	1,721	2,723	1,601	16,683
2018	86,036	51,790	7,801	3,147	3,457	1,697	18,144
2019	100,215	56,107	13,221	5,230	4,569	1,812	19,276
2020	113,003	59,177	19,160	7,441	5,230	1,932	20,063
2021	120,018	59,774	24,984	7,658	4,916	2,022	20,664
2022	124,803	60,521	26,915	8,249	4,800	2,430	21,888

Table: Transitions in international student numbers in non-degree programs by country of origin

Fiscal Year	Total	Vietnam	China	Japan	Mongolia	France	Others
2010	23,842	252	13,546	2,740	1,139	360	5,805
2011	25,884	392	13,210	3,215	1,185	499	7,383
2012	26,289	569	13,448	2,825	1,168	586	7,693
2013	29,208	860	13,923	3,136	1,414	758	9,121
2014	31,255	1,033	15,854	2,542	890	814	10,122
2015	35,593	1,872	19,327	2,031	993	977	10,393
2016	41,158	3,993	21,178	2,108	2,177	987	10,715
2017	51,826	9,916	23,578	2,227	2,661	1,233	12,211
2018	56,169	19,260	16,747	2,280	3,311	1,146	13,425
2019	59,950	24,205	14,960	2,580	2,812	1,283	14,110
2020	40,692	19,177	7,853	1,242	1,612	1,119	9,689
2021	32,263	10,859	7,574	1,796	1,112	1,631	9,291
2022	42,089	11,025	6,918	3,303	2,548	2,247	16,048

Source: Korean Basic Education Statistics 2022

What kind of work is foreign talent living in South Korea engaged in? Examining by visa category, the number of individuals engaged in research had remained at around 3,000 annually, but surged in 2021, reaching a record high (3,638). The number of university faculty members engaged in research (listed as "professor" in Table 2-7) has remained at around 2,000 annually.

Table 2-7: Numbers of foreign talent in South Korea by visa type

ビザ類型	2013	2014	2015	2016	2017	2018	2019	2020	2021
計	50,166	49,503	48,607	48,334	47,404	46,851	46,581	43,258	45,143
短期就職	460	593	594	594	1,719	1,302	1,645	2,356	1,691
教授	**2,637**	**2,664**	**2,612**	**2,511**	**2,427**	**2,341**	**2,187**	**2,053**	**2,017**
外国語指導（会話）	20,030	17,949	16,144	15,450	14,352	13,749	13,910	12,621	13,403
研究	**2,997**	**3,195**	**3,145**	**3,174**	**3,214**	**3,145**	**3,132**	**3,110**	**3,638**
技術指導	222	186	192	187	185	191	220	199	177
専門職	667	645	606	618	597	606	624	374	257
芸術	4,940	5,162	4,924	4,302	3,704	3,633	3,549	3,011	3,285
特定活動	18,213	19,109	20,299	21,498	21,206	21,884	21,314	19,534	20,675

Source: Ministry of Justice Korean Immigration Service: "Korean Immigration Statistics Annual Report and Immigration and Foreign Policy Statistics Monthly Report"

2.4 Papers and Patents

Academic papers are a primary indicator for measuring research achievements and are used to judge a country's research capabilities and academic level. As shown in the figure below, the number of papers published in South Korea has been increasing annually, surpassing 76,000 in 2020. In terms of global ranking, South Korea has maintained the 12th position since 2007.

According to KISTEP's "Analysis of Scientific and Technological Paper Achievements 2011-2020," the average number of citations per Korean paper was 5.13 in 2016, below the global average of 5.35, but it exceeded the global average of 6.04 with 6.36 in 2020, clearly indicating a significant improvement in the quality of papers in recent years.

Furthermore, according to NISTEP's "Science and Technology Indicators 2022," South Korea surpassed Japan for the first time in the average number of **top 10% corrected papers (2018-2020), ranking 11th** (Japan ranked 12th). The term "Top 10% adjusted paper count" refers to the number of papers that, after extracting those whose citation counts fall within the top 10% for each year and field, are adjusted to become a real number equating to one-tenth of the paper count. It is an indicator used to measure the quality of papers, signifying the number of papers that are frequently cited (i.e., papers with a high degree of attention). While there's no dispute that the quality of Korean papers has improved, given the recent decline in Japan's top 10% adjusted paper numbers, it might be more appropriate to analyze that South Korea surpassed Japan not because of Korea's advancement but because of Japan's decline.

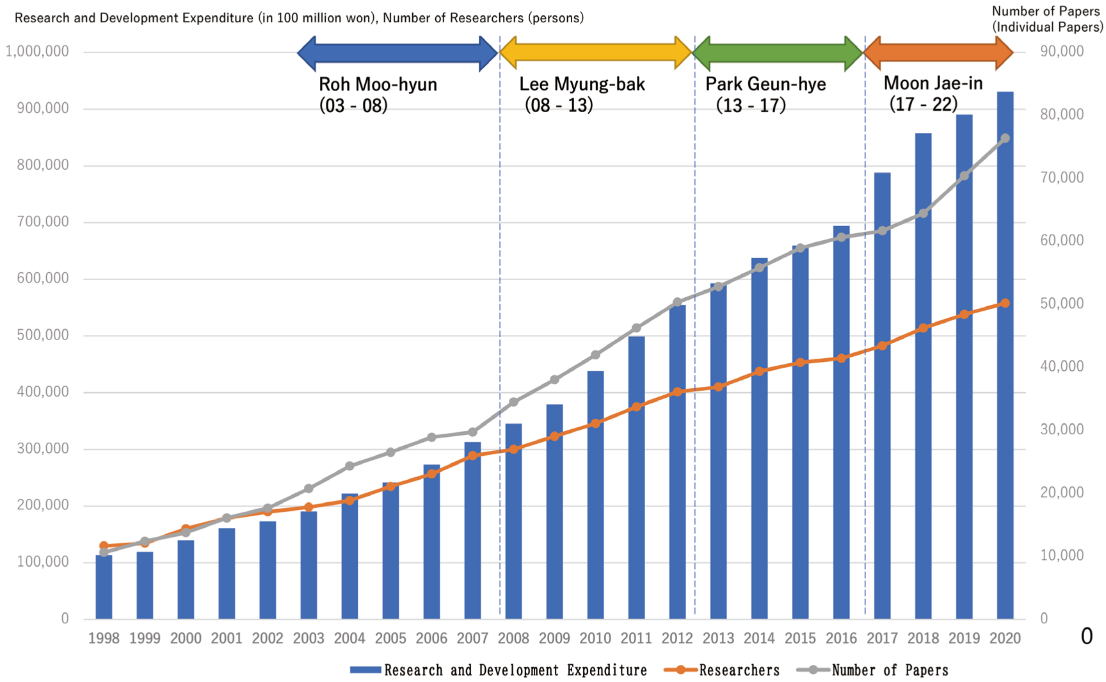


Figure 2-8 Transitions in research and development expenditure, number of researchers, and number of papers by government

Source: NTIS "Science and Technology Statistics"

Table 2-9 Top 10% Adjusted Paper Numbers (Fractional Count)[17]

全分野	2018 — 2020年（PY）（平均）		
	Top10%補正論文数		
国・地域名	分数カウント		
	論文数	シェア	順位
中国	46,352	26.6	1
米国	36,680	21.1	2
英国	8,772	5.0	3
ドイツ	7,246	4.2	4
イタリア	6,073	3.5	5
オーストラリア	5,099	2.9	6
インド	4,926	2.8	7
カナダ	4,509	2.6	8
フランス	4,231	2.4	9
スペイン	3,845	2.2	10
韓国	3,798	2.2	11
日本	3,780	2.2	12
イラン	3,504	2.0	13
オランダ	2,859	1.6	14
スイス	2,143	1.2	15
ブラジル	2,095	1.2	16
スウェーデン	1,546	0.9	17
シンガポール	1,442	0.8	18
トルコ	1,386	0.8	19
ベルギー	1,326	0.8	20
デンマーク	1,292	0.7	21
台湾	1,249	0.7	22
サウジアラビア	1,247	0.7	23
ポーランド	1,225	0.7	24
エジプト	1,059	0.6	25

Source: NISTEP "Science and Technology Indicators 2022"

17 Fraction count. If a paper is co-authored by Institution A in Japan and Institution B in the United States, it is counted as 1/2 for Japan and 1/2 for the United States, indicating the level of contribution to paper production. The whole number method counts one paper co-authored by Institution A in Japan and Institution B in the United States as 1 for Japan and 1 for the United States, indicating the level of involvement in paper production. Both counting methods use the country of the author's affiliated institution.

Japanese	English	Japanese	English
全分野	All Fields	スペイン	Spain
2020 年 (PY) (平均)	2020 (PY) (Average)	韓国	South Korea
Top10% 補正論文数	Top 10% Adjusted Paper Numbers	日本	Japan
分数カウント	Fractional Count	イラン	Iran
論文数	Number of Papers	オランダ	Netherlands
シェア	Share	スイス	Switzerland
順位	Rank	ブラジル	Brazil
国・地域名	Country/Region	スウェーデン	Sweden
中国	China	シンガポール	Singapore
米国	USA	トルコ	Turkey
英国	UK	ベルギー	Belgium
ドイツ	Germany	デンマーク	Denmark
イタリア	Italy	台湾	Taiwan
オーストラリア	Australia	サウジアラビア	Saudi Arabia
インド	India	ポーランド	Poland
カナダ	Canada	エジプト	Egypt
フランス	France		

Table 2-10 Top 10% Adjusted Paper Numbers (Whole Number Count)

Rank	Country	2016 to 2020: Top 10% Number of Papers
1	USA	346,791
2	China	239,068
3	UK	119,655
4	Germany	88,668
5	Australia	61,323
6	Canada	58,583
7	Italy	57,765
8	France	56,765
9	Spain	45,149
10	Netherlands	42,285
11	Japan	38,442
12	India	33,190
13	Switzerland	32,653
14	South Korea	31,867

Source: KISTEP "Analysis of Scientific and Technological Paper Achievements 2011-2020"

In patents, South Korea's PCT patent application numbers have been increasing annually, ranking fourth in 2021, following China, the United States, and Japan. Germany was in fourth place until 2019, but South Korea surpassed Germany in 2020.

Papers and patents are major indicators of a country's research capability, and South Korea is showing steady growth in these areas.

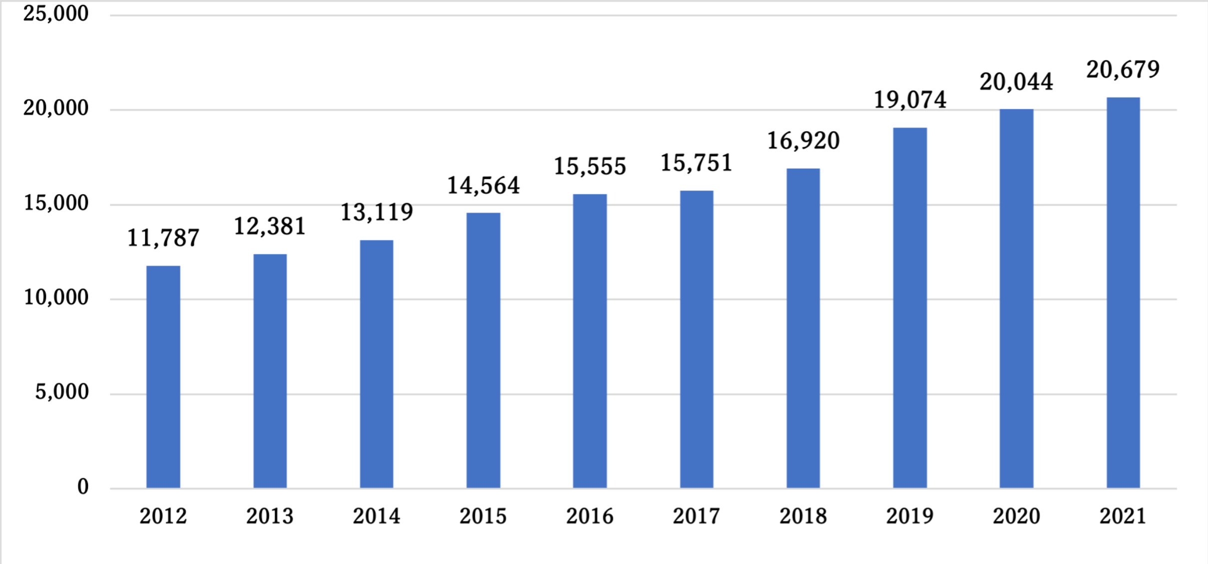


Figure 2-11 Transitions in South Korea's PCT Patent Applications

Source: NTIS "Science and Technology Statistics"

2.5 Other - Indicators Representing Scientific and Technological Strength

The fact that South Korea is sending so much research talent into society and the ranking of Korean universities among the world's top 100 universities clearly demonstrates that its research capabilities are growing stronger. The number of Korean universities ranked in QS's world top 100 universities increased from 4 in 2016 to 6 in 2022, and the universities listed in the Times Higher Education (THE) world top 100 universities increased from one in 2016 to two in 2022.

In the IMD World Competitiveness Ranking, Korea leaped from 7th place in 2013 to 3rd place in 2022. Moreover, the brain drain ranking (an indicator showing the extent to which a country's talented individuals move abroad, with lower ranks indicating a more severe situation) improved from 46th place in 2016 to 24th place in 2021, showing an improvement.

As seen above, South Korea is showing progress across various indicators. However, the next chapter will show how it has been focusing on securing and developing talent to influence its research strengths and international competitiveness in science and technology.

3 South Korea’s Basic Policies and Primary Measures for STI Talent Development

Chapter 3 clarifies the policies and projects South Korea has been promoting to cultivate and secure STI talent.

3.1 Basic Policies for STI Talent Development

South Korea experienced a currency crisis (national financial bankruptcy) in 1997 and received a bailout from the International Monetary Fund (IMF). Subsequently, a significant increase in non-regular jobs led to many research positions being temporary. As a result, an image of research being an unstable career was established, and the number of students entering science and engineering departments decreased sharply. In response, the government established the "Special Act on Supporting Talents in Science and Engineering" in 2004 to encourage students to pursue science and engineering fields. To implement more specific support measures, the "Basic Plan for Nurturing and Supporting Scientific Talent" was initiated in 2006. This is an important national plan established once every five years (linked to changes of government), with the most recent being the fourth plan from 2021 to 2025[18]. (hereinafter "the Fourth Talent Plan"). Many countries announce policies for developing talent, but it is quite rare for a country to focus specifically on science and technology talent.

South Korea places great emphasis on science and technology, as can be seen in Article 127 of the Constitution stating, "The State shall strive to develop the national economy by developing science and technology, information and human resources, and encouraging innovation."

The Fourth Talent Plan details development and support plans for future layers of talent, such as improving the mathematical and scientific capabilities and digital literacy of elementary and middle school students, young researchers, mid-career researchers, female researchers, and promising talent from abroad. **It is the country’s most important and fundamental policy in science and technology talent training and support.** Its specific content is presented below.

(1) Vision and Goals

The plan sets the goal of becoming a "science and technology talent powerhouse leading innovation in an era of great transformation,” with three major policy goals to realize this vision being proposed. The first is to secure talent capable of adapting to future changes, the second is to continue to maintain and expand the scale of science and technology talent, and the third is to establish a system for transforming into a talent-inflow country (a country that attracts outstanding science and technology talent from overseas).

18 Full text: https://spap.jst.go.jp/resource/pdf/aprc-fy2022-pd-kor04.pdf

(2) Main Content

The specific tasks to promote the plan's goals are broadly divided into four categories.

(2.1) The development of basic talent with a stable foundation in preparation for a future full of changes.

According to the results of a 2019 Times Higher Education (THE) survey, among the 58 countries surveyed, the interest level in mathematics for fourth-grade elementary school students in South Korea ranked 57th and 53rd in science, and for second-year middle school students, it ranked bottom among the participating countries. The government took these results seriously and decided to construct (in 2022) and operate (in 2023) an artificial intelligence-based math study system tailored to the level of students to improve their math and science abilities. Furthermore, by 2024, it plans to install science rooms in all elementary, middle, and high schools and increase opportunities to experience science both inside and outside of school. In 2022, it also began construction of the STAR (school teachers and research institute) Bridge Center. The STAR Bridge Center is a project where universities, research institutions, and local communities cooperate to educate and develop talent in elementary, middle, and high schools. Universities and research institutions can be involved in the composition of textbooks and curricula, while school teachers can enhance their expertise by receiving training at universities and research institutions.

(2.2) Substantial support for young researchers who will play leading roles in the future.

The support programs for young researchers are detailed in section 3.2, so they are only briefly mentioned here.

Firstly, to enable master's and PhD students to conduct research with fewer economic burdens, they are provided with a monthly living allowance. Additionally, to solve the problem of not being able to secure their own research time due to having to do work for their supervising professors, more research supporters are being hired. In addition, to ensure research is performed in safe environments, the law was amended to include accidents occurring in university laboratories and research facilities under workers' compensation insurance, and a system was established whereby qualified laboratory safety managers manage the safety of laboratories.

Furthermore, to strengthen support for postdoctoral researchers, new initiatives such as the KIURI project and the Sejong Science Fellowship have been promoted, enabling about 300 more individuals to receive support annually.

(2.3) Actively inviting outstanding researchers from overseas.

The project to invite outstanding foreign researchers is detailed in section 3.5, and so is only briefly summarized here.

The South Korean government is focusing on improving systems and projects to ensure that outstanding foreign researchers can settle in South Korea and continue their research activities in a stable manner. Firstly, since 2020, improvements have been made to invitation procedures and the visa system to facilitate smooth entry and settlement to support the Brain Pool Plus project (an effort to attract high-class foreign talent), which is planned to be carried out on a scale of 600 million won annually for up to ten years. Additionally, to support foreign researchers unfamiliar with life in South Korea, the LINKO Center was established in 2021 to provide necessary information on daily life and research activities. It plans to actively support researchers to start companies and find employment according to their career history.

Legislative amendments have also been made to allow researchers to engage in a broader range of activities. For example, previously if a researcher was invited as a university professor for a specific subject, they were not allowed to teach subjects other than the designated ones, and holding a job elsewhere was prohibited. However, as of December 2020, the Basic Law on Intelligent Informatization was amended, recommending researchers be able to work multiple jobs (including dispatch work) at research institutions and companies from the perspective of promoting mobility of talent. Restrictions on the subjects they are responsible for have been lifted, allowing for a flexible curriculum system according to researchers' preferences.

(2.4) Supporting continued research amongst women and senior researchers.

Due to concerns about population decline and talent acquisition, South Korea is devising ways to ensure researchers can remain active in the labor market throughout their lives without exiting mid-career.

Firstly, with a focus on universities and research institutions, measures such as expanding flextime, telework, and discretionary work systems have been introduced to enable female researchers to balance childbirth, childcare, and work. Efforts are being made to hire temporary replacements during maternity leave to facilitate a smooth return to the field after the leave. According to the glass ceiling index[19] surveyed among OECD member countries by The Economist, South Korea has been at the bottom of the ranking for countries where it is easy for women to work since 2013[20]. The reasons for this last-place ranking include wage disparities with men, a low number of women in management positions, and a culture of having to choose between work and family[21]. To improve this situation, since 2023 South Korea has been considering making paternity leave for male researchers mandatory and the construction of a substitute worker database.

To support senior researchers, outstanding researchers can extend their retirement age (currently retirement is at 60), and since 2020, the government has been providing continued employment support funds to companies[22].

Some major companies have taken the initiative to implement continued employment. For example, Samsung Electronics[23] introduced a senior track system in 2022, revising its personnel system to allow outstanding engineers and researchers to continue working in the company even after retirement. SK Hynix also introduced a technical expert system in December 2018, lifting the age limit for outstanding technical experts, and employs senior researchers as faculty members to operate SK Hynix University (SKHU)[24] (an in-company initiative). SKHU, which has been operating since 2017, follows a university credit system for social education and training. Unlike other companies' education that typically lasts several months, it offers long-term education over 8 years. Technical staff become students of SKHU upon joining the company and can graduate upon earning 50 credits. Graduation takes about 8 years due to parallel work commitments. Employees spend 8 years studying a wide range of content from basic to specialized knowledge necessary for semiconductor experts. SK Hynix introduced this system to bridge the gap between theory and practice among its employees and to avoid the competition for talent acquisition by nurturing semiconductor talent in-house. Additionally, all instructors are senior researchers or engineers at SK Hynix, helping to realize continued employment.

19 See: https://www.economistgroup.com/group-news/the-economist/women-are-still-not-having-it-all-according-to-the-economists-2022-glass.

20 South Korea ranks 29th out of 29 countries. Japan ranks 28th.

21 The gender pay gap is 31.5%, the percentage of women on corporate boards is just 8.7%, and in management positions, it is 15.6%. Furthermore, although perceptions are changing with the times, statistics show that Korean women have serious worries about continuing their jobs after marrying.

22 See: Ministry of Employment and Labor's "Let's Make Use of the Continued Employment System" at https://www.moel.go.kr/news/enews/report/enewsView.do?news_seq=12573.

23 See: Dong-A Ilbo, "There is no retirement age for technology talent, focus on corporate movements" (February 2022) https://www.donga.com/news/article/all/20220213/111762075/1.

24 For details, see SKHU News "SKHU: Cultivating National Representatives for Semiconductors" (May 2017) https://news.skhynix.co.kr/post/nurture-the-semiconductor-national-team ; The Korea Economic Daily "SKHU President, Sharing the Know-How of Seniors" (March 2022) https://n.news.naver.com/mnews/article/015/0004673869?sid=101.

The government has also been promoting a mentoring project by senior researchers since 2021, with an annual budget of 1.5 billion won, to encourage the active participation of senior researchers. This includes providing government subsidies when small and medium-sized enterprises hire senior researchers as technical advisors or when senior researchers are employed as instructors in science classes for youth.

In addition to the four promotion tasks mentioned above, under the Basic Plan, various personnel training projects (including various plans and measures for talent training) by science and technology field and career are also being launched, some of which are introduced below.

By field:

- Semiconductors: "Semiconductor-Related Talent Training Plan (2022.7)"
- Artificial Intelligence: "National AI & SW Education Promotion Guidelines (2020.8)"
- ICT: "Growth Support Plan for Science, Technology & ICT Talent Capable of Responding to the Fourth Industrial Revolution (2018.11)"
- Biotechnology: "Bioindustry Talent Training & Business Promotion Guidelines (2020.9)"

By career:

- Gifted Talent: "Third Comprehensive Plan for Discovering and Training Scientific Talent (2018-2022)"
- Young: "Mid- to Long-Term Science and Technology Talent Policy Toward 2030 (2019.2)"
- Mid-career: "Direction of Mid- to Long-Term Reform of Science and Technology Talent Policy (2020.6)"
- Women: "Fourth Plan to Train and Support Female Scientists and Engineers (2019-2023)"
- Senior: "Guidelines for Utilizing Senior Science and Technology Talent After Retirement (2020.5)"

These policies outline goals and implementation plans. Their specific realization is achieved through science and technology talent training projects.

The science and technology talent training policies enacted under the **Yoon Suk-yeol administration (May 2022-)** include "Semiconductor-Related Talent Training Plan 2022," "Digital Talent Training Plan 2022," and "Advanced Technology Field Talent Training Strategy 2023" in addition to the previously mentioned plan. As is evident from the document titles, the new administration is focusing on securing and training talent in advanced science and technology fields.

Semiconductor-Related Talent Training Plan 2022[25]: Consists of three main pillars: (1) expanding the staffing quota for semiconductor departments in universities and graduate schools, (2) strengthening industry-academia-government collaboration through large-scale semiconductor R&D projects, and (3) establishing semiconductor talent training hubs centered around universities.

Digital Talent Training Plan 2022: Calls for (1) training high-level practical talent through deregulation and bold reforms, (2) cultivating talent that can apply digital technology to domain areas, (3) developing talent that can utilize digital technology in daily life, and (4) introducing digital-related knowledge as a liberal arts subject.

25 For more detailed information, please see SPAP "Korea - Competing in Semiconductors, Declares it Will Train 150,000 Semiconductor Talents Over 10 Years". https://spap.jst.go.jp/korea/experience/2022/topic_ek_13.html

Advanced Technology Field Talent Training Strategy 2023: Presents talent training strategies in five advanced technology fields: (1) aerospace industry, (2) biohealth industry, (3) semiconductor & battery industry, (4) digital field, and (5) environment & energy sector.

It is worth mentioning that, along with the emphasis on training science and technology talent, **platforms focused on science and technology talent are also very well developed.** Some of the representative ones include, firstly, (1) the **Science and Technology Talent Policy Platform**[26]. This is a portal site operated by the Ministry of Science and ICT (MSIT) and the Korea Institute of Science and Technology Evaluation and Planning (KISTEP) since 2018. It not only promptly reports on policies and business trends related to securing and training science and technology talent in South Korea and around the world but also provides various statistics and indicators (over 90) related to science and technology talent. It also introduces in detail the latest plans and policies of the Korean government related to science and technology talent, as well as ongoing projects and events, thus providing a wide range of information related to science and technology talents. Next is, (2) the **R&D JOB Engineering Talent Placement Center**[27], which has been operated by the Korea Industrial Technology Association since 2019 and is designated as an engineering talent employment support institution by MSIT. The site serves as a recruitment site for engineering masters and PhDs, where graduates can upload their resumes along with desired salaries and working conditions, and companies can post their job listings along with information about themselves. Companies can also directly scout students, and students can apply directly to companies they're interested in. Additionally, this platform provides one-on-one career counseling to students both online and offline, as well as support for aptitude tests and resume writing. Finally, (3) the **Science and Technology Talent Career Support Center**[28] provides a variety of services such as career experiences, company visits, and career counseling for elementary and middle school students interested in science and technology. It also introduces promising future careers and allows students to have their level of talent confirmed by professionals. Moreover, if interested, students can check the career paths of professionals in their fields of interest and apply for online consultations with professionals they consider as role models. The purpose of this center is to provide a variety of career options to elementary and middle school students with potential or a general interest in science and technology, offering hints to them about talents they themselves may not be aware they have.

However, based on these policies and platforms, what kind of talent training projects have been undertaken? The following section provides details on these projects, divided into domestic training of research personnel, overseas training of researchers, inviting foreign researchers and attracting international students to South Korea.

3.2 Major Policies on Domestic Training of Research Personnel

The domestic training projects for research personnel are developed around two main pillars: **training of research personnel and training of practical personnel**.

[26] https://www.hrstpolicy.re.kr/

[27] https://www.rndjob.or.kr/

[28] https://www.sciencecareer.kr/kor/Main.do

3.2.1 Training Projects for Research Personnel

(3.2.1.1) Graduate Student Training Projects

Training projects for research personnel are broadly divided into support for master's and PhD graduate students and support for postdoctoral researchers. A typical support project for graduate students is the comprehensive support provided to students at universities specialized in science and technology.

In South Korea, there are **universities specialized in science and technology,** whose main purpose is research in science and technology. These universities are research-centered, and although they have fewer students compared to comprehensive universities, they are characterized by their varieties of scholarships and a high number of faculty members per student. **The four major institutes of science and technology**[29]**: Korea Advanced Institute of Science and Technology (KAIST), Gwangju Institute of Science and Technology (GIST), Daegu Gyeongbuk Institute of Science and Technology (DGIST), and Ulsan National Institute of Science and Technology (UNIST), are joined by Pohang University of Science and Technology (POSTECH).** Graduate students at these universities **can conduct research without almost any financial burden, regardless of whether they are in master's or PhD programs.**

Taking KAIST as an example[30], all graduate students are scholarship students, divided into three types: government-sponsored students, KAIST-sponsored students, and industry-academia-sponsored students, receiving tuition and scholarships. Government-sponsored students have their full educational expenses covered by the government, are automatically granted teaching assistant qualifications, and receive a monthly allowance (265,000 won for master's students and 450,000 won for PhD students). Additionally, if a student applies and works as a TA (Teaching Assistant), they receive an additional 500,000 won monthly. Furthermore, living expenses are provided up to a limit of 1.8 million won for master's courses and 2.5 million won for PhD courses per month (the amount is determined at the discretion of the supervising professor). KAIST-sponsored students (called supervising professor-sponsored students) have their monthly wages and living expenses determined through consultation with the supervising professor before admission. For KAIST-sponsored students, since the amount provided is at the discretion of the supervising professor, there is a significant disparity. To guarantee a certain standard of living for students, the STIPEND scholarship system started in 2019. This system ensures a minimum monthly payment of 700,000 won for master's courses and 1 million won for PhD courses by KAIST. If a master's student receives a monthly 500,000 won for payroll and living expenses from the supervising professor, the university adds an additional 200,000 won. Industry-academia-sponsored students are supported by companies for tuition and wages, but in return, the students must work for the company for a certain period after graduation. For industry-academia-sponsored students, the amount provided varies by company, but it is around 1 million won per month for master's courses and approximately 1.8 million won for PhD courses.

Similar levels of generous support[31] are provided at other universities specialized in science and technology.

- POSTECH: Fellowships, student teaching assistant allowances (master's: 1.38 million won per month, PhD: 1.85 million won), and other support funds (can receive more than one at once)
- GIST: Tuition is free for master's, PhD, and integrated master's PhD programs, with only an admission fee of

29 The four major institutes of science and technology are research-centered educational institutions, established by special laws and under the jurisdiction of MSIT, and are technically research institutions rather than universities.

30 For details, see https://ee.kaist.ac.kr/admission-03/.

31 For details, see each university's website.

680,000 won required. Academic encouragement money, meal subsidies, and research encouragement money are provided to all, with master's students guaranteed an amount equivalent to 610,000 won per month, and PhD students 1.37 million won.

- UNIST: All graduate students are classified as government sponsored students, UNIST sponsored students, and general scholarship students. A monthly stipend system exists, guaranteeing a minimum of 800,000 won per month for master's students and 1.1 million won for PhD students.
- DGIST: Since 2019, tuition has been set at 3.5 million won per semester, but it is refunded in full through scholarships. Additionally, living expense payments of 328,500 won per month are guaranteed.

Moreover, research personnel studying at these specialized universities in science and technology can prevent research gaps due to military service using the **specialized researcher system**. The specialized researcher system targets individuals enrolled in or having completed master's or PhD programs in science and engineering fields who can contribute to the country, allowing them to be exempted from military service by working (researching) for three years at companies, universities, or research institutions designated by the military. For master's programs, the selection competition is fierce, but for PhD programs, a number of positions equivalent to the number of entrants are allocated annually to universities specializing in science and technology, making it a system where essentially everyone can participate if they wish. Although it is a system with a long history, implemented since 1973, there has been continuous controversy over selection process fraud, having others work by proxy, and issues surrounding misuse of talent[32], and there are still many voices calling for its abolition.

An indispensable support project for graduate students is **BRAIN KOREA (BK).** The BK project, led by the Ministry of Education, aims to nurture research personnel, primarily graduate students, and world-class universities and graduate schools. Starting in 1999, the program runs in seven-year phases. Repeatedly extended, it is currently in its fourth period (September 2020 - August 2027). It is one of the few large-scale R&D projects[33] in South Korea that continues regardless of government changes. Through BK4, 19,000 graduate students receive support annually, with master's students receiving a monthly amount of 700,000 won, PhD students 1.3 million won, and PhD graduates more than 1 million won. Thanks to the BK project, the number of SCI papers in South Korea has significantly increased, universities have established a research-centered system, and along with enhancing research capabilities, the production of papers by university faculty has also improved[34].

This substantial research support for graduate students is still limited to a few universities, but it is available not only to PhD students but also to master's students, and companies are also actively participating in graduate student support projects, which is a characteristic unique to South Korea.

32 The purpose of the system is to for participants to continue their research instead of military service, but some companies overload students with tasks while paying them minimum wage, treating them practically as errand runners for three years, creating a significant problem. A KAIST student who received unfair treatment raised his voice in dissatisfaction, saying, "King Sejong elevated slaves to scientists, but Korea turns scientists into slaves." See https://namu.wiki/w/%EC%A0%84%EB%AC%B8%EC%97%B0%EA%B5%AC%EC%9A%94%EC%9B%90%20%ED%8F%90%EC%A7%80%20%EB%85%BC%EB%9E%80 for reference.

33 BK1 (March 1999 - February 2006, investment scale 1.57 trillion won), BK2 (March 2006 - February 2013, investment scale 1.7566 trillion won), BK3 (September 2013 - August 2020, investment scale 2 trillion won), BK4 (September 2020 - August 2027, investment scale 2.9 trillion won).

34 Examining the actual results, during BK1, the number of SCI papers increased from 9,444 in 1999 to 18,497 in 2006, and in BK2, the impact factor index per paper of faculty members participating in the BK project rose from 2.17 to 2.98. In BK3, the number of SCI paper citations rose from 30th to 20th place, and the number of universities selected in the top QS ranking increased from 6 to 11.

(3.2.1.2) Postdoctoral Support Projects[35]

This section examines the kinds of support provided to postdoctoral researchers. Initially there were just three support projects for postdocs.

Firstly, there was a domestic and international postdoc training support project implemented by the Ministry of Education in 1996. For those who have obtained a PhD in science and engineering but have not secured a post, this project supports continued research as a postdoctoral researcher at outstanding research institutions domestically and internationally, avoiding career gaps. The target is those who have obtained a doctoral degree in science and engineering within the last 7 years, and it provides about 60 million won yearly. The support period is 1 to 3 years, with approximately 900 postdoctoral researchers receiving support from this project annually. The budget for 2022 was 53 billion won.

The second was a research institution fit-type talent training project implemented by the National Research Council of Science & Technology[36] since 2009. There are 25 research institutions under the National Research Council of Science & Technology, each of which recruits and supports the postdoctoral talent needed by these research institutions annually. This project prioritizes students who have obtained a PhD in science and engineering from overseas universities, targeting those who have obtained their degrees within the last 5 years. The research fields recruited vary each year depending on the annual research themes and survey contents of the research institutions, but the average annual salary for postdoctoral researchers receiving support is 50 million won. Unlike other projects, despite a support period of up to two years, severance pay is provided, and the four major insurances are provided during the period. 112 individuals were recruited under the project in 2022.

The third was the Innovation Challenge Research Foundational Support Project implemented by the National Research Foundation of Korea (NRF) in 2012. It is open to applications from those in the field of science and engineering, with approximately 2,800 individuals receiving support of up to 70 million won annually. The support period is 1 to 3 years, with a budget of 155.5 billion won in 2022, supporting 2,800 individuals.

In addition to these projects, the Korean Research Foundation commenced the KIURI project in 2020 to further strengthen support for postdoctoral researchers. The KIURI (Korea Initiative for fostering University of Research & Innovation) project supports postdoctoral researchers in several fields considered to be main industries in the era of the Fourth Industrial Revolution, where cooperation with companies is expected to play a major role. The target is those who have obtained a PhD within the last 5 years and are under 39 years old, with a support amount of about 50 million to 100 million won annually for up to three years. The 2020 KIURI project started with four universities, each responsible for a specific field. Seoul National University is responsible for biohealth, Sungkyunkwan University for energy and the environment, Yonsei University for future automobile components, and POSTECH for biotherapeutics. In 2021, two universities were added, Inha University in the field of hydrogen and Asia University in the field of biotechnology. The budget for 2022 is 12 billion won, with 92 people receiving support.

Furthermore, MSIT commenced the Sejong Science Fellowship project in 2021, targeting those in the field of science and engineering who have obtained their PhD within the last 7 years or are under 39 years old. The support amount per person is up to 100 million won annually, with a childcare allowance also provided if raising children. The

35 For details on postdoctoral support projects, refer to STEPI's "Scale and Characteristics of Postdoctoral Researchers in Korea I-II (2020, 2022)."

36 An institution under MSIT that supports government-funded research institutions in the field of science and technology.

support period is longer than the four projects mentioned above, up to 5 years. The budget for 2022 was 310 billion won, with about 900 people receiving support.

The Science and Technology Policy Institute (STEPI) conducted surveys on the scale and situation of postdoctoral researchers, including the number of researchers, twice, in 2020 and 2022. This was the first time South Korea systematically conducted a survey on postdoctoral researchers. According to the survey, although support for postdoctoral researchers has been strengthened, three out of ten are still not receiving the average annual salary in South Korea, and four out of ten are struggling to find work. There are more and more support projects for postdoctoral researchers each year along with greater government emphasis, and the scale of support is also expanding, but compared to the United States and European countries, it is still not sufficient, and more comprehensive support projects are needed.

3.2.2 Training Projects for Practical Personnel

The Korean government is focusing on practical personnel to the same extent as researchers. Practical personnel refer to highly skilled talent that can immediately contribute to companies and workers needed in the field.

Why is the development of this talent an important issue? According to the "Fourth Basic Plan for Nurturing and Supporting Science and Technology Personnel," South Korea is facing a serious mismatch problem between industrial demand and talent supply. As shown in Figure 3-1, companies with the most demand for talent are those in the field of information and communication, followed by machinery, and transportation & construction, but the majority of master's and doctor's graduates are in the field of biotechnology, creating a mismatch with company needs.

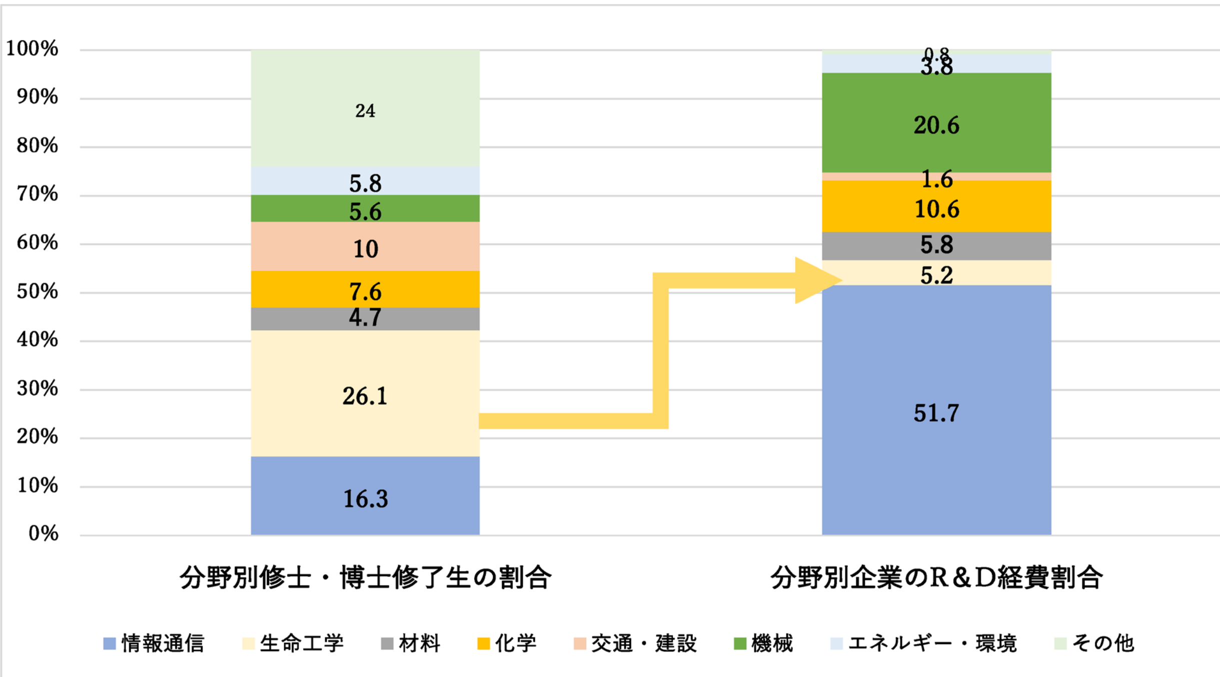


Figure 3-1 The mismatch between personnel needed by companies and master's & PhD graduates

Source: Fourth Basic Plan for Nurturing and Supporting Science and Technology Personnel

Japanese	English
分野別修士・博士修了生の割合	Percentage of master's and PhD graduates by field
分野別企業の R&D 経費割合	Percentage of R&D expenses by companies by field
情報通信	Information and communication
生命工学	Biotechnology
材料	Materials
化学	Chemistry
交通・建設	Transportation & construction
機械	Machinery
エネルギー・環境	Energy & environment
その他	Other

To solve these issues, the Korean government is implementing various measures aimed at developing practical personnel, considering the needs of the industry.

(3.2.2.1) Introduction of Contract Departments

The government began by introducing contract departments.

Due to the strengthening of industry-academic-government cooperation, companies have been demanding that universities cultivate personnel with practical skills Based on Article 8 of the Industry-Academic Cooperation Act in South Korea, since 2003 universities have been able to establish faculties and departments through contracts with industries (companies) and local governments to respond to the diverse needs of industries. These **departments established through contracts between companies and universities are called contract departments. Students entering contract departments receive support such as tuition fees from companies but are obliged to work for the company for a certain period after graduation.**

Universities establish new departments in accordance with the demands and needs of companies and develop curricula to cultivate the optimal personnel required by companies. These departments are more practical than theoretical, and students undergo frequent corporate training so they can contribute to companies immediately after graduation. Not only do companies bear all or part of the educational costs necessary for the operation of these departments, but they also provide benefits such as in-house training, overseas training, and scholarships to students. For students, these are exceptional conditions.

When the act was established, contract departments did not receive much attention due to anxieties surrounding it being a new system and the obligation to work for several years for a company after graduation. A semiconductor department born from the contract between Samsung Electronics and Sungkyunkwan University in 2006 was the first contract department, and it took five years until 2011 for the second contract department to emerge, a mobile engineering department from a contract between Samsung Electronics and Kyungpook National University. Subsequently, around 2021, the situation took a rapid turn, with a shortage of talent in advanced technology fields during the Fourth Industrial Revolution, along with increased popularity of contract departments due to the general difficulty in finding employment outside of advanced technology fields. The shortage of personnel in semiconductors was particularly notable, and universities and companies actively worked on establishing semiconductor departments. According to the Korea Semiconductor Industry Association, the workforce in the semiconductor industry was 177,000 people in 2021, and it is expected to increase to 304,000 people within the next 10 years. This means that by 2030, at least 127,000 individuals with talents in semiconductors need to be secured, but the current supply is not meeting demand. According to the Ministry of Trade, Industry and Energy, statistical results indicate a shortage of 1,621 people in 2020 alone. A summary of the major contract departments at this stage is as follows:

Table 3-2 List of Major Contract Departments in South Korea

Universities	Businesses	Department	Number of Recruits
Sogang University	SK Hynix	System Semiconductor Engineering Department	20
Hanyang University	SK Hynix	Semiconductor Engineering Department	24
Korea University	SK Hynix	Semiconductor Engineering Department	20
Korea University	Hyundai Motor	Smart Mobility Department	30
Korea University	Samsung Electronics	Next Generation Communications Department	18
KAIST	Samsung Electronics	Semiconductor System Engineering Department	90
POSTECH	Samsung Electronics	Semiconductor Engineering Department	40
Yonsei University	Samsung Electronics	System Semiconductor Engineering Department	40
Sungkyunkwan University	Samsung Electronics	Semiconductor System Engineering Department	40
Kyungpook National University	Samsung Electronics	Mobile Engineering	30

Source: EDUJIN[37]

As can be seen from the table above, the vast majority of contract departments between top universities and major companies are semiconductor related. The number of fields, such as smart mobility and communications, is also increasing.

[37] EDUJIN: “Graduate and get employed by a major company at the same time! Summary of contract departments" (August 2022) http://www.edujin.co.kr/news/articleView.html?idxno=39614

As a countermeasure against the monopolization of talent by large corporations, the Ministry of Education has provided an option for early employment type contract departments for small and medium-sized enterprises[38]. In early employment type contract departments, employment at a small or medium-sized enterprise is confirmed at the time of university admission. For the first year, students receive systematic education in theory and practice at the university, and in their second and third years, they work at the company while also attending university classes. Students decide on the company of their choice after receiving detailed explanations about each company at briefing sessions and promotional meetings before admission (multiple applications are allowed). These departments have high relevance to the Fourth Industrial Revolution and are focused on fields such as biotechnology, future automobiles, software, and smart industry. The advantages of early employment type contract departments include being able to graduate from university in three years, acquiring two years of work experience simultaneously with graduation, no special work obligations after graduation, being in a favorable position for employment or job change in high-demand industrial fields, and lower competition rates compared to the contract departments of large corporations. The Ministry of Education has been promoting this project with an annual budget of 9.6 billion won since 2020, and currently, 28 early employment type contract departments have been established at 8 universities. Over 1,000 students per year benefit from this (1,329 students in the 2021 academic year), and small and medium-sized enterprises are evaluating the system favorably as it helps them secure talent in highly competitive technological fields.

(3.2.2.2) Projects for Cultivating Master's and Doctoral Personnel for Companies

The government is also focusing on the cultivation of research personnel equipped with practical skills capable of solving problems encountered in the field.

The Ministry of Trade, Industry and Energy is promoting a project for the cultivation of high-level innovation personnel to lead new industries. This project mainly involves cultivating master's and PhD personnel needed by new industries such as the BIG3 industries[39] (future automobiles, next-generation semiconductors, biohealth), mobility, smart sensors, AI, etc. Since the aim is to cultivate high-level personnel needed by the industry, the graduate schools involved in this project set up practical-centered curricula, incorporating internships at companies and joint project practice with companies rather than classes. 96.3 billion won in support was provided to these graduate schools and joint projects (in 2021), and 881 master's and PhD students graduated. The budget for 2022 was increased to 116.5 billion won, and projects for cultivating personnel with practical skills capable of responding to new industries are expected to continue expanding.

A company-collaborative research and development personnel training project promoted by the Ministry of SMEs and Startups aims for master's and PhD students at universities to research and solve problems faced by small and medium-sized enterprises in the form of industry-academia joint projects, with each project receiving support of 300 million. In 2021, 7.1 billion won was spent on the project, and approximately 200 master's and PhD talents graduated.

[38] There are also contract departments for small and medium-sized enterprises that students can enter on the condition that they work for the company afterwards. Limited to new industries and specialized regional industries, the contract departments are newly established, and students attend curricula necessary for the type of personnel required by companies, with the government supporting tuition fees and companies providing support funds (equivalent to scholarships) necessary for research activities. Students are then required to work for the company for at least two years after graduation. This project started in 2020 and is being expanded with an annual scale of about 1.8 billion won. In 2021, 91 students were supported under the project.

[39] For details on the BIG3 industries, see https://spap.jst.go.jp/korea/experience/2023/topic_ek_03.html.

The government is enhancing support for research and development by small and medium-sized enterprises, such as tax deductions for the establishment costs of corporate-affiliated research institutes and R&D expenses at research institutes. Like in other countries, research personnel in South Korea tend to concentrate in universities, research institutions, and large corporations, causing small and medium-sized enterprises to struggle to acquire research personnel. Industry-academia joint projects are considered a reliable form of support for small and medium-sized enterprises.

(3.2.2.3) Projects to Support the Employment of PhD and Postdoctoral Researchers in Companies

In recent years, the Korean government has been actively deploying projects to support the employment of PhD and postdoctoral researchers in companies. Similar to Japan, in South Korea, PhD and postdoctoral researchers tend to congregate in universities and public research institutions rather than companies, causing companies to struggle with a shortage of high-level talent and PhD and postdoctoral researchers to face difficulties in employment due to limited positions being available. This project can be described as killing two birds with one stone, addressing both the shortage of talent in companies and the employment rate of PhD and postdoctoral researchers. The government provides benefits such as support for recruitment expenses and tax deductions to companies that actively hire PhD and postdoctoral researchers and offers scholarship opportunities and chances for overseas training that lead to career advancement for PhD and postdoctoral researchers employed in small and medium-sized enterprises.

The Ministry of Science and ICT (MSIT) first tackled a specialized technical training project for the engineering sector, essentially a matching project for master's and PhD talents with small and medium-sized enterprises. The project introduces students who have not decided on employment after completing their master's or PhDs to small and medium-sized enterprises through training and career consulting. MSIT spends more than 10 billion won annually (12.6 billion won in 2021, 16.1 billion won in 2022), training master's and PhD graduates at research institutions and small and medium-sized enterprises for 9 months to acquire skills and knowledge necessary for working in companies. Afterward, through one-on-one consultations with career consultants, they provide support leading to employment. Annually, more than 200 master's and PhD graduates (250 in 2021, 285 in 2022) find employment in small and medium-sized enterprises through this project. Moreover, MSIT operates a portal site called R&D JOB[40] that provides intermediation for the employment of engineering research personnel in companies, having provided 15,754 career consultations in 2021 and held 9 recruitment fairs, connecting many research personnel with small and medium-sized enterprises.

MSIT has also launched a young technical talent corporate collaboration project, which dispatches master's and PhD graduates to companies. The project involves dispatching graduates with master's or PhDs in science and engineering to workplaces (small and medium-sized enterprises) where the commercialization of technology or the transformation of results is needed, as part of their practical experience, for a period of 8 months (training period). These individuals contribute to solving company issues while gaining career experience in companies. 11 billion won in support funds were provided in 2021, with 720 individuals participating. Among them, those who utilized this experience to gain employment in companies accounted for about 30%, or 210 people.

40 www.rndjob.or.kr

3.3 Major Policies for the Overseas Development of Young Talent

The main projects supporting overseas research and training for outstanding young talent include, firstly, the project mentioned in 3.2.1, which supports science and engineering PhD graduate researchers to continue their research overseas (Domestic and International Postdoc Training Support Project).

Additionally, there is a global in-the-field learning project, which supports overseas language training and internships for young talents. This project, deployed by the Ministry of Education, offers opportunities for outstanding university students to gain experience overseas. More than 10 billion won is spent on the project annually (13.4 billion won in 2021), supporting about 2,000 students (1,937 in 2021). The project has three main types. Firstly, a U.S.-Korea undergraduate student training project (WEST: Work, English Study, Travel). The project has been promoted since 2009 in-line with the MOU signed at the 2008 U.S.-Korea summit. WEST supports Korean university students to undergo language training and internships in the United States for 6 to 18 months[41], and benefits more than 300 students annually. The second is a poverty support project, providing four weeks of overseas training opportunities for university students who excel in their studies but could not otherwise study overseas due to financial difficulties. The third is a credit acquisition support project, exclusively supporting outstanding students to undertake training at universities and research institutions overseas for a certain period to earn credits.

Additionally, the government operates a portal site called K-MOVE[42], supporting passionate and potential young Korean talent to work around the world and become active globally. K-MOVE provides career consultation, job introductions, and financial support for settling overseas for talent wishing to work or start a business abroad.

In addition, a long-standing Japan-Korea joint high school student exchange project, ongoing since 1999, also helps to support globally-minded young talent. Until 2018, this project was promoted under the name of the Japan-Korea joint science and engineering undergraduate study abroad support project, but in 2019 it was reorganized as the Japan-Korea joint high school student exchange project. It now supports master's and PhD students in all fields. For undergraduate students, it offers short-term study abroad and one-year exchange programs. For graduate students, only those aiming to obtain a degree are eligible. Selected students receive full tuition, living expenses (800,000 won per month for undergraduates, 900,000 won + thesis printing fees for graduate students), round-trip airfare, medical insurance (up to 20,000 won per month), and money to settle in the country (200,000 won).

3.4 Key Policies on Supporting Female SIT Talent

South Korea, like Japan, is a country where population decline is a serious social issue. In 2002, the Act on Fostering and Supporting Women Scientists and Technicians was enacted, providing a legal foundation for the support of women in science and technology. This law defines female SIT talent as those engaged in research, technical positions, or related industries in the science and engineering fields, or those who intend to do so.

In 2004, South Korea established **a basic plan for cultivating and supporting female talent in science and**

41 These programs are divided into short-term, medium-term, and long-term, with short-term being 6 months, medium-term 12 months, and long-term 18 months. They include one month of travel time.

42 https://www.worldjob.or.kr/ovsea/biIntro.do

technology, running on a five-year cycle. The concept of a periodic plan to specifically support women's activities in SIT is a rare move worldwide. So far, four basic plans have been implemented, with their main contents as shown in the table below.

Table 3-3 Comparison of the 1st to 4th Basic Plans for the Cultivation and Support of Female Talent in SIT

	First Basic Plan ('04 - '08)	Second Basic Plan ('09 - '13)	Third Basic Plan ('14 - '18)	Fourth Basic Plan ('19 - '23)
Vision	To realize a science and technology-centered society with a balance of female scientists and engineers	To realize an innovative science and technology society led by female scientists and engineers	Science and technology and a creative economy built together by both men and women	A society where the innovative capabilities and potential of female scientists and engineers can be realized
Goals	- To expand the potential utilization of science and technology talents by encouraging women to enter the field of science and technology - To strengthen overall competitiveness through leveling up female science and technology talents - To improve the potential and social status of female science and technology talents - To utilize science and technology talents in rural areas and eliminate regional disparities	**- To increase the proportion of high-level female science and technology talents** (1) Raise the proportion of female college students in science and engineering to 25% (2) Cultivate 1,000 female PhDs in science and engineering (by 2013) **- Utilize female science and technology talents** (1) Ensure 10% of jobs for female science and technology talents (2) Raise the proportion of female leaders in national research and development projects to 10% **- Build and strengthen the foundation for nurturing and utilizing female science and technology talent** (1) Continuously expand the budget related to female science and technology talent	**- Challenges** (1) Employment rate of 60% for female college students in science and engineering (2) 15% of PMs to be women **- Balance** (1) Increase the proportion of women's jobs in science and technology R&D to 20% (2) Raise the economic participation rate of women in their 40s in science and technology to 60% **- Diversity** (1) 10% enrollment rate for female science and technology talent (2) Establish guidelines for R&D gender analysis	**- Prevention of loss, promotion of growth** (1) Maintain a 30% proportion of female college students in science and engineering (2) Cultivate 3,000 female science and technology talents in new industries **- Expand women's activities and participation** (1) Increase women's jobs in the R&D field of science and technology to 30% (2) Raise the economic participation rate of women in their 40s in science and technology to 70% (3) Expand the participation of female committee members regardless of age
Promotion Strategy	- Encourage women to pursue studies in science and engineering - Strengthen training for quality improvement - Strengthen promotional activities through various media - Strengthen cooperation with government agencies and local governments - Induce participation from corporations and the private sector	**- Develop** Encourage women to pursue science and engineering studies while strategically developing high-level talents **- Utilization** Increase jobs and promote career advancement **- Infrastructure** Improve the environment in research society, strengthen investment	- Attract and strengthen the utilization of outstanding female science and technology talent - Strengthen the global competitiveness of female science and technology talent - Increase quality jobs for female science and technology talent - Consider work-life balance for science and technology talent - Create an environment with a balanced (healthy harmony) gender ratio	- Strategic talent attraction, growth promotion - Strengthen global innovation capabilities - Career development, expansion of utilization - Build a gender innovation system

Source: Created by the author based on the content of the Basic Plans

The basic plans have evolved from building a support foundation for female researchers in science and technology (1st), strengthening the foundation of activities (2nd), presenting plans related to cultivation and activities (3rd), to emphasizing qualitative improvement (4th), taking into consideration the characteristics of female SIT talents who are also scientists and technologists.

To promote support projects for women in science and technology, the **Center for Women in Science, Engineering and Technology (WISET)** was established in 2011. Numerous support projects have been commenced since 2002 when the Act on Fostering and Supporting Women Scientists and Technicians was enacted. Examples include a WISE mentoring project for women in science and technology and female college students, a WIST support project for women in science and technology talent, a WIE support project for female college students in science and engineering, and a WATCH21 project for cultivating female talent in science and engineering. These were all integrated, and WISET was born in 2011 as an affiliate of the Korea Science Foundation (KSF). In 2017, WISET was designated as an institution under the **MSIT.**

WISET is currently implementing three projects.

(3.4.1) First, aiming to increase the number of female college students in science and engineering, it provides career counseling and experience opportunities for girls with talent in science and engineering fields in elementary, middle, and high schools. It also utilizes science and technology that students are interested in, such as VR/AR, to promote science and engineering-related occupations, encouraging girls to have an interest in these fields.

(3.4.2) Next, for female college and graduate students in science and engineering, it provides employment support and mentoring, etc. In science and engineering fields with a low proportion of women, there are few role models, leading many students to feel anxious about their career paths. To address this issue, WISET collaborates with domestic and foreign companies and research institutions to meet with graduates working in the field, and hold company visits, career experience events, lectures, etc. It also provides entrepreneurship training for students who aim to start their own businesses and implements one-on-one entrepreneurship support programs. From 2013 to 2021, a total of 4,817 female college and graduate students received mentoring, and from 2020 to 2022, 548 received entrepreneurship support.

(3.4.3) It also supports the prevention of career gaps for women in science and technology talent and their return to work after childbirth and child-rearing. For female researchers who cannot find employment after graduation or are aiming to return, WISET conducts training for 3 to 11 months. The content of the training mainly involves knowledge and technology related to new technologies and new industries, such as information security, artificial intelligence, and big data.

To facilitate the return of female researchers with career gaps, it searches and provides matching research institutions, providing 21 million won per year for researchers with a master's degree or equivalent research capabilities, and 23 million won for PhDs. This support can be received for up to three years, and from 2012 to 2021, a total of 1,200 recipients were able to return to work. Of the women who were able to return to careers thanks to WISET, 79.2% have continued to work, and the average number of papers produced within three years after returning is 2.5 per individual.

To support the work-life balance of female researchers, WISET also supports research institutions to recruit staff. When a researcher takes maternity leave for three months or more, it supports the personnel costs (21 million won per person for masters, 23 million won per person for PhDs) for the institutes to recruit replacements. Additionally, if a researcher has to work reduced hours due to childcare, it encourages the additional recruitment of female researchers, supporting the necessary personnel costs (10 million won per person for those with at least a bachelor's degree, 30 million won per person for postdoctoral researchers). This not only supports the work-life balance of female researchers but also supports female researchers employed as replacements. In 2021, 782 female researchers obtained jobs as replacements, of which 72.6% successfully transitioned to regular employment. Moreover, 80% (in 2021) of female researchers who took parental leave successfully returned to work.

Besides WISET, there are multiple other organizations supporting female researchers in South Korea, such as the Korean Federation of Women's Science and Technology Associations (KOFWST) and the Korean Women's Development Institute (KWDI), providing substantial support to these talents.

These systematic support policies and comprehensive support from major support organizations are likely producing a synergistic effect.

3.5 Key Policies on Recruiting Foreign Researchers

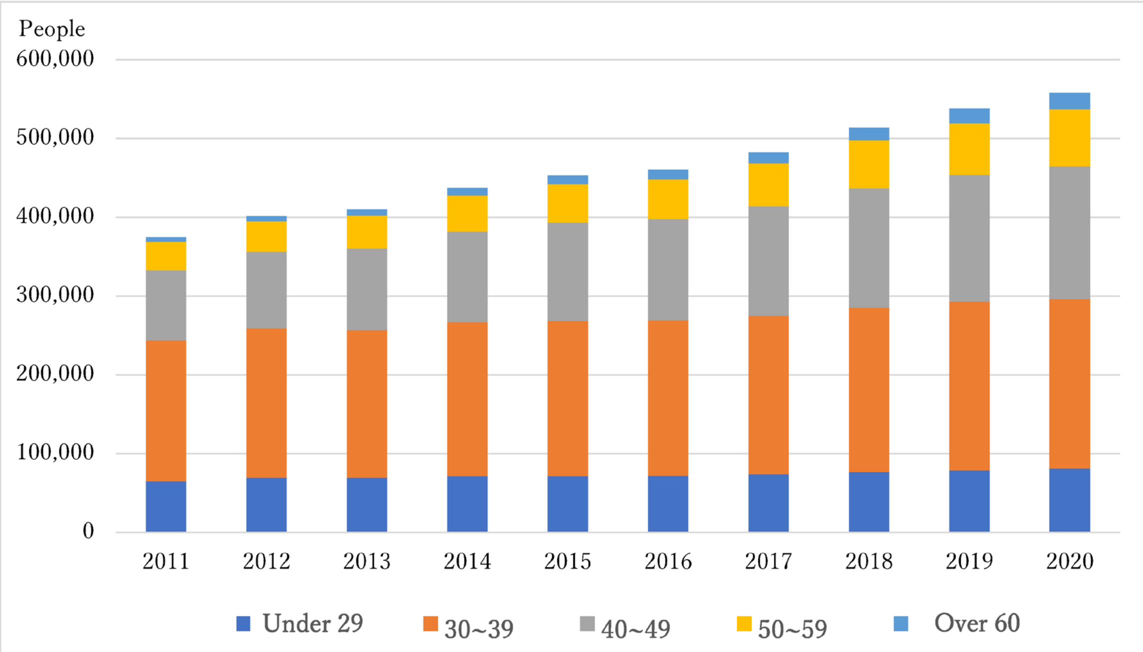


Figure 3-4 Number of Researchers by Age in South Korea

Source: NTIS Science and Technology Statistics

The figure above shows the number of researchers by age group in South Korea. Although the total number of researchers is increasing, the number of young researchers under 39 remains unchanged, and the number of older researchers over 40 is increasing, indicating that aging is also progressing among researchers. In South Korea, where the birth rate is lower than in Japan, population decline is progressing and becoming a serious issue, making foreign researchers a valuable asset for Korean society. The South Korean government is working on various measures to attract outstanding foreign talent.

3.5.1 Brain Pool and Other Projects to Attract Outstanding Researchers from Overseas

This section starts by discussing a project to attract outstanding researchers from overseas, primarily managed by the MSIT and the National Research Foundation of Korea (NRF).

This project, commonly known as BRAIN POOL, is a long-standing project that began in 1994. Initially named the High-level Science Intellect Recruitment Utilization Project, its name was changed to the Project to Attract Outstanding Overseas Researchers in 2021. BRAIN POOL's goal is to invite outstanding scientists from overseas to the domestic research and development scene, enhance the level of research and development, and build an international cooperation network. All fields of science and technology are targeted by the program. Individuals targeted include those residing overseas with a PhD or those without a PhD but with over five years of research and development experience in foreign companies (regardless of nationality). The support scale is divided into short-term and long-term Short-term is for 6 to 12 months and long-term is for 3 years. Annual salaries are determined within a range of 5 million won to 25 million won per month, while guaranteeing the same salary from the individual’s original place of work. Additionally, a separate 1 million won per year is provided for research material costs, along with expenses for airfare, insurance, children's tuition, and living expenses, with up to 12 million won per year being paid for long-term cases. In 2023, the project plans to newly invite approximately 122 people.

BRAIN POOL has been producing stable results but faces challenges such as limitations in recruitment strategies and the low long-term settlement rate amongst participants. According to the 2021 Execution Plan for the Attraction of Outstanding Researchers from Overseas established by MSIT in 2020, the invitation of foreign researchers should be based on a database of outstanding researchers from overseas. However, a database of this kind does not exist in South Korea, so recruitment was dependent on personal connections in research labs at various universities, leading to limitations in the invitation project. Examining the situation in 2020, 87.9% of participants were invited through the networks of research labs at Korean universities, indicating the need for a more systematic recruitment strategy. Furthermore, foreign researchers who stayed in South Korea expressed the need for a service or platform for obtaining information about South Korea's research environment and employment, and to further improve the environment for becoming established in South Korea (employment for spouses, education for children).

Taking into account the above issues and feedback, the South Korean government opened a portal site called RDIK[43] in 2021 to encourage outstanding overseas researchers to settle in South Korea. RDIK features policies related to research by various South Korean ministries, information on R&D projects that foreign researchers can participate in, the latest research trends, and essential information for life in South Korea (visa, taxes, insurance, guidance on various facilities), fully supporting foreign researchers to settle in the country.

Additionally, in response to the fourth industrial revolution, the BRAIN POOL PLUS project was newly launched in 2020 to attract higher-level talent. This is an upgraded version of BRAIN POOL, with the same targets as BRAIN POOL, but aims to invite world-class talent from outstanding research institutions abroad to work as regular employees in South Korea. The support scale is more substantial than BRAIN POOL, with a period of stay of up to 10 years and employment at research institutions in South Korea as a regular staff member. Direct costs of personnel expenses and research activities are provided at up to 600 million won per year. Additionally, indirect costs equivalent to 5% of the researcher’s annual salary are also provided. It plans to invite around 5 individuals in 2023.

Table 3-5 BRAIN POOL Project Results

Fiscal Year	94～11	2012	2013	2014	2015	2016	2017	2018	2019	2020	Total
Budget (million won)	61,741	3,500	3,150	3,150	3,000	2,838	2,838	2,838	7,874	9,046	99,975
New invitees (persons)	1,488	63	63	61	63	54	64	53	97	71	2,077

43 rdik.or.kr

Table 3-6 Invitations from Each Country for BRAIN POOL & BRAIN POOL PLUS Combined

Fiscal Year	India	United States	South Korea (for those affiliated with overseas research institutions)	China	France	Japan	Russia	Canada	Germany	United Kingdom	Other	Total
2019	91	21	67	35	7	3	5	2	5	3	100	339
2020	89	24	68	28	5	2	5	5	1	3	129	359
2021	88	35	66	28	7	3	5	2	3	2	153	393

To ensure the smooth operation of the BRAIN POOL and BRAIN POOL PLUS programs, the talent matching platform RPIK[44] is also being operated. This platform matches foreign researchers with domestic research institutions, allowing foreign researchers wishing to work in South Korea to smoothly proceed to interviews with the platform's support by simply uploading their resumes, etc. 364 foreign researchers have already registered, and 406 South Korean research institutions are also participating. This effort is gradually resolving the issue of relying on university labs or individual connections to recruit talent.

Following the Plan to Attract 300 of the World's Top 1% Scientists established by MSIT in 2013, scientists corresponding to the top 1% are being invited to South Korea, mainly through the Institute for Basic Science (IBS). The top 1% scientists referred to here are authors of papers corresponding to the top 1% of citations in their field or whose papers have been published in renowned journals (NSC: Nature, Science, Cell, etc.), as well as recipients of science awards (Nobel Prize, Wolf Prize, Albert Lasker Award for Basic Medical Research, etc.). The goal is to invite about 20 people annually, but the number of invitees has exceeded the target each year. 460 individuals were successfully invited to work in South Korea by 2021, close to 500 people over about 10 years.

3.5.2 Improvement of Treatment for Foreign Talent

To ensure that the aforementioned foreign talent settles in South Korea and can conduct research in South Korea more stably and for a longer period, the Ministry of Justice is also working on improving the visa system.

From 2021, those holding a research (E-3) visa and teaching at South Korean universities or research institutions can now conduct lectures outside their contracts without separate permission. In addition, researchers affiliated with overseas research institutions visiting South Korea for joint research can now be issued visas without having to establish an employment relationship with domestic research institutions, provided there is an invitation from a university. This has made it possible for visiting researchers to come to South Korea on a research visa.

Additionally, to secure young talent with high-potential, international students expected to obtain a master's or PhD at specialized universities and research institutions in the field of science and engineering[45] can stay for 5 years with an F-2 (long-term stay visa) even if they cannot find a job immediately after graduation. Foreign nationals employed by (or expected to be employed by) venture or startup companies in promising technology fields are granted an F-2 visa regardless of their stay duration. Normally, a minimum stay of 3 years is required to obtain an F-2, but exceptionally

44 http://rpik.co.kr/

45 This refers to the 33 institutions specified in the "Act On the Establishment, Operation and Fostering of Government-Funded Science and Technology Research Institutes."

lenient conditions are applied to young foreign talent.

From 2022, a points-based system was introduced for foreign specialized talent. Previously, activities outside one's field of expertise were prohibited for specialized talent, but high-income earners (those with an income three times or more than South Korea's per capita gross national income) and highly educated individuals[46] are now free from this restriction, applying a negative list approach where they can freely engage in activities and change jobs, except in prohibited industries. Furthermore, the use of internships at domestic companies, previously limited to foreign students studying at domestic universities, has been expanded to include graduates or students of outstanding universities overseas, allowing up to a six-month stay.

3.6 Key Policies for Attracting International Students

To attract outstanding international students to South Korea, the Korean government has launched comprehensive support projects for academics and employment. First, a variety of information for students who want to study in South Korea is provided through a platform called Study in Korea[47]. This portal site, operated by the Ministry of Education, provides various information related to studying in South Korea (information on Korean universities and their various programs for international students, scholarship information, employment information, etc.) and also offers information on the King Sejong Institute[48] where students can learn Korean both online and offline. The King Sejong Institute, a language school offering lessons in Hangul, is currently operated in 18 countries and has a total of 234 schools. Students who wish to study in South Korea or are currently studying can find the information they need by visiting Study in Korea.

This section examines the scholarships available to support international students. The Global Korea Scholarship (GKS) project[49], promoted by the Ministry of Education, includes wide ranging support, from government-funded international student support to self-financed students and exchange student support.

The government-funded international student support project is provided under the title The Korean Government Scholarship Program for International Students. It offers wide-ranging support for both undergraduate (bachelor's and specialist degrees[50]) and graduate students (master's and PhDs). The support period is the standard graduation period plus an additional year for language training. Scholarship recipients receive tuition fees, medical insurance, round-trip travel expenses, and dissertation printing fees, in addition to research fees (about 210,000 to 240,000 won per semester), a support fund to settle in South Korea of 200,000 won (once only), a return preparation fund of 100,000 won (once only), and a monthly living expense (800,000 to 900,000 won). Additionally, those fluent in Korean receive an extra 100,000 won per month.

46 Age, Korean language ability, income, and educational background are the main criteria for evaluation, which are quantified

47 www.studyinkorea.go.kr

48 https://www.iksi.or.kr/lms/main/main.do

49 For information on The Korean Government Scholarship Program for International Students, see: http://www.niied.go.kr/user/nd74554.do and https://namu.wiki/w/%EB%8C%80%ED%95%9C%EB%AF%BC%EA%B5%AD%20%EC%A0%95%EB%B6%80%20%EC%B4%88%EC%B2%AD%20%EC%9E%A5%ED%95%99%20%EC%A0%9C%EB%8F%84.

50 In South Korea, a technical college is a type of higher education institution focused on vocational education, with a study period of 2 to 3 years. Graduates receive a specialist bachelor's degree.

About 250 self-financed overseas students[51] receive support each year of up to 500,000 won per month for a maximum of 10 months (two semesters). The aforementioned Japan-Korea joint high school student exchange project[52] also supports Japanese students studying in South Korea (undergraduate and graduate students). Support for master's and PhD students is only aimed at those seeking degrees, with benefits similar to those for government scholarship students. Approximately 15 students receive support annually. For undergraduate students, there are 1-year courses and short-term courses (2 to 5 weeks or about 3 months), with the 1-year course providing tuition fees, living expenses (800,000 won per month), round-trip travel expenses, medical insurance, and support funds of 200,000 won (once only) to become settled in South Korea. Tuition fees, accommodation costs, program participation fees, and round-trip travel expenses are provided for short-term courses. Annually, 25 people benefit from the 1-year course, and 160 people from the short-term course.

Since 2009, the South Korean government has been operating the Korea Trade-Investment Promotion Agency (KOTRA) which provides comprehensive support for international students to become employed so that they can work in South Korea and contribute to Korean society after graduation. It provides matching between companies and international students as well as full support for the entire process of employment, from interviews to contracts, all free of charge. Furthermore, it conducts regular surveys on overseas talent trends, attracting required talent through proactive overseas promotion and talent discovery activities for Korean companies and research institutions. Additionally, the Korean government regularly holds job fairs for foreign students to support their employment.

51 For details, see: http://www.niied.go.kr/user/nd72767.do and https://namu.wiki/w/%EC%9A%B0%EC%88%98%20%EC%9E%90%EB%B9%84%20%EC%9C%A0%ED%95%99%EC%83%9D(%EC%99%B8%EA%B5%AD%EC%9D%B8)%20%EC%A7%80%EC%9B%90.

52 This program supports not only Japanese students studying in South Korea but also Korean students studying in Japan. For more details on the project, see: http://www.niied.go.kr/user/nd34267.do and https://namu.wiki/w/%ED%95%9C%EC%9D%BC%20%EA%B3%B5%EB%8F%99%20%EA%B3%A0%EB%93%B1%EA%B5%90%EC%9C%A1%20%EC%9C%A0%ED%95%99%EC%83%9D%20%EA%B5%90%EB%A5%98%EC%82%AC%EC%97%85.

4 Evaluation and Characteristics of South Korea's SIT Talent Cultivation and Retention, and Areas of Reference for Japan

This paper has introduced South Korea's efforts in securing and cultivating science and technology talent.

Despite its focus on numerous policies and projects for science and technology talent, where does South Korea stand in this field globally?

South Korea has grown from a country dependent on support from developed countries, including the United States, to one of the world's top 10 economic powers (ranking 10th in the world based on nominal GDP according to 2021 IMF statistics). A large part of this growth can be attributed to national research and development projects. Through long-term science and technology policies, both the government and the private sector have promoted R&D investment, making significant strides in industries such as information and communication, semiconductors, automobiles, shipbuilding, displays, and petrochemicals. Although the government's R&D budget has increased, since the 1980s, private R&D investment has surpassed that even of the government, maintaining a share of over 70% of R&D expenses from 1983 to the present. With the expansion of investment in research and development, the demand amongst industry and research has led to an annual increase in the number of researchers, making South Korea the country with the highest number of researchers per capita.

Despite a shorter history in research and development compared to other countries, South Korea has quickly narrowed the gap, growing into a powerhouse with the world's 5th largest R&D expenditure and the 2nd highest ratio of R&D expenditure to GDP. In terms of outcomes generated by investment in research and development, the country’s numbers of academic papers and patent applications have continuously increased, ranking 12th in the world for the number of papers and 5th for the number of PCT patent applications. According to the IMD World Competitiveness Yearbook 2022[53], South Korea's competitiveness ranked 27th, surpassing Japan (34th), and its science and technology infrastructure was marked 3rd in the world. In the WIPO Global Innovation Index (GII) 2022[54], South Korea was ranked 6th, outperforming other Asian countries such as China (11th), Singapore (7th), and Japan (13th).

So, which of the policies and projects introduced in this document can Japan refer to? From here on, we will focus on suggestions for Japan.

53 Full text: https://worldcompetitiveness.imd.org/countryprofile/overview/KR

54 Full text: https://www.wipo.int/global_innovation_index/en/2022/

4.1 Evaluation and Characteristics of South Korea's SIT Talent Cultivation and Retention

First, let's summarize the unique features of South Korea's SIT talent development and retention strategies.

(1) Focus on gifted education

As mentioned in 3.1, South Korea emphasizes the importance of laying a solid foundation in the development of science and technology talent and is focused on education for the gifted in science and technology. Thanks to this, South Korea's performance in the International Science Olympiad has always been excellent. In the 2019 results, South Korea ranked first in physics, chemistry, earth science, and biology, third in mathematics and astronomy, and fourth in informatics, leading in many fields. Needless to say, these gifted talents in science and technology are becoming a valuable source of personnel to support the future development in these fields. However, it is worth noting that the focus is not just on the selection and development of students with potential. The government is also making efforts to create an environment and infrastructure in schools where elementary, middle, and high school students naturally become familiar with digital technology and science. Schools have transcended places of learning knowledge to become spaces that enrich students' imaginations and allow them to interact with science and technology through enhancements in facilities and teacher training, among other areas. Thanks to this, many students have become interested in the field of science and technology, which has also led to their active participation on the international stage.

(2) Substantial support for young talent to establish careers

As introduced in 3.2, South Korea provides multifaceted support to ensure that PhD graduates can continue their research even if they do not immediately find a job after graduation. This support is not just financial. It also includes counseling on career paths, one-on-one consultations, and a variety of career options. Besides universities and research institutions, matching projects with companies are also emphasized. The government also provides free training and internships for researcher talent considering employment in companies to become established in their roles, even paying their salaries during the training period.

Additionally, to prevent research gaps, information is provided regarding participation in short-term R&D projects at companies or research institutions until employment. Arrangements are also made for these individuals to engage in curriculum research at local elementary, middle, and high schools, joint research with teachers, or mentoring in research if necessary.

As introduced in section 3.2.1, support programs for postdoc researchers have been increasing every year, and the number of R&D projects available for participation and the treatment of postdoctoral researchers is improving. Most postdoc support programs are aimed at those in science and engineering who have obtained their doctorate within the past seven years or are under 39 years of age, making the scope of eligible participants relatively broad. The KIURI project and the Sejong Science Fellowship have been well received due to the remarkable results from their first years of implementation. These results have led to increases in participating universities and in the scale of the projects.

The specialized researcher system, which takes into consideration the period of military service, also shows consideration for researchers. Military service is a unique factor in South Korea, making it difficult to compare with other countries. However, the fact that special relief measures are well established to prevent disadvantages due to interrupted research in a system where there are almost no exemptions from military service obligations for professional reasons is commendable.

(3) A Rich Array of Platforms Focused on Science and Technology Talent

Another characteristic feature of South Korea's science and technology talent development is the extensive support provided by its platforms.

As introduced in 3.1, representative platforms include (1) the Science and Technology Talent Policy Platform, (2) the R&D JOB Engineering Talent Placement Center, and (3) the Science and Technology Talent Career Support Center, among others. However, there are also a variety of other platforms. For example, the NKIS platform[55] supports researchers studying national policies, the ENG JOB platform[56] supports engineers with practical skills, and the W-BRIDGE platform[57] supports women in science and technology.

In addition, there are support platforms specific to different fields of science and technology, such as BIO JOB[58] for the biotechnology sector, IP-R&D[59] for intellectual property and patents, and ECO JOB[60] for the environmental sector.

There are more than 30 of these platforms and they are characterized by their focus on talent in the field of science and technology. These various platforms play an important role in helping secure and develop science and technology talent in South Korean society.

(4) Emphasizing the Link between Science and Society from the Perspective of Talent Development

In South Korea, the phrase "science culture" has become quite established.

For example, there is a profession in South Korea called " scientific and cultural experts[61]." They devise methods to spread difficult-to-understand science and technology in a clear and interesting manner to society through lectures, videos, books, comics, etc. The phrase science culture began to spread gradually during the Roh Moo-hyun administration. Roh Moo-hyun argued that if science and technology were to aim for groundbreaking development from its current level, it should become something familiar that exists everywhere in life, a kind of culture, likening it to how a wave of Korean culture has spread worldwide. Subsequent efforts raised science and technology to the level of culture and disseminated it throughout society.

In Japan, science and technology communicators play the role of connecting various stakeholders through science museums. They actively promote research activities through co-creation and engaging in multifaceted science and technology communication activities such as dialogs and collaboration efforts. According to a document by the National Museum of Emerging Science and Innovation (Miraikan) about science communicators[62], up until 2017, this

55 https://www.nkis.re.kr/

56 https://www.engjob.co.kr/

57 https://www.wbridge.or.kr/

58 https://www.biojob.co.kr/main/index.html

59 https://biz.kista.re.kr/

60 https://www.ecojob.re.kr/

61 For details, see the Science Culture Talent Development Platform https://sciculture.kofac.re.kr/main.do

62 National Museum of Emerging Science and Innovation "About Science Communicators at Miraikan" (2017) https://www.mext.go.jp/b_menu/shingi/gijyutu/gijyutu2/092/shiryo/__icsFiles/afieldfile/2018/01/17/1400272_002.pdf

role involved not only communicating the content of science and technology in an understandable and interesting way but also conveying the general public's questions and expectations to researchers, creating two-way communication. Since then, this role refers to individuals trusted by the general public who can promote dialogs and consultations among various stakeholders to produce innovation in science and technology. Today's science communicators in Japan can talk on equal terms with researchers, conveying to them a broader-reaching perspective and science communication skills from the perspective of society. The role of South Korea's specialists in science and technology culture is not exactly the same but is similar to Japan's science communicators up to 2017. South Korea also provides science and technology from the perspective of "science culture" to its citizens. Being more culture focused makes this a concept slightly different from Japan's.

MSIT also operates a science culture portal[63] called Science All so that anyone can easily access and learn information and knowledge about science and technology when needed. It includes over 30,000 pieces of content, including trivia related to science and technology, a science and technology encyclopedia, information on nationwide science and technology-related events, and science and technology project information themed around science culture. To make it approachable for people of all ages, information is delivered in various formats, including online cartoons (webtoons)[64], live broadcasts, games, and articles, tailored to the theme. STAR-MOOC[65], jointly launched by the five major universities specializing in science and technology[66] and the University of Science and Technology (UST), is an online open course in the field of science and technology, offering a valuable platform where various lectures from top-level science and technology specialized universities can be attended for free. Since professors from the above universities provide lessons on STAR-MOOC, its content is said to be of very high quality. Along with a website, there is also a smartphone app, allowing lectures to be downloaded and viewed anytime, anywhere. There are both one-time seminars and longer courses, similar to university courses, that span over ten sessions. The levels range from basic to advanced, meeting a wide variety of needs. Alongside the above platforms, the government is accelerating the establishment of science culture by expanding science museums and children's science experience spaces nationwide.

4.2 Matters Japan Should Consider When Advancing Science and Technology Talent Development and Retention

So far, this article has analyzed the unique features of South Korea's science and technology talent development and retention strategies. From here it will discuss matters that Japan should consider amongst South Korea's strategies.

(1) Ongoing, stable, and expanding investment in science and technology, R&D projects, and talent development

First and foremost, investment in science and technology that is at once ongoing, stable, and expanding is crucial.

63 https://www.scienceall.com/

64 A type of digital comic originating from South Korea.

65 https://www.starmooc.kr/

66 Korea Advanced Institute of Science and Technology (KAIST), Gwangju Institute of Science and Technology (GIST), Daegu Gyeongbuk Institute of Science and Technology (DGIST), Ulsan National Institute of Science and Technology (UNIST), and Pohang University of Science and Technology (POSTECH)

The economic benefits of investing in science and technology innovation (impacts on GDP, employment, private investment, etc.) can be expected to have permanent effects by increasing the economic growth rate, as well as produce notable social effects such as addressing climate change, energy, and population issues, and ensuring safety and security. The size of the science and technology budget is also directly linked to scientific and technological competitiveness, including the number of academic papers published[67]. Over the past 20 years, Japan's research and development expenses have remained almost flat. By comparison, South Korea has shown an increasing trend. Although still behind Japan in total, its momentum of growth is noteworthy. South Korea's research and development expenditure has skyrocketed from 1.2 billion won in 1963 to over 102 trillion won in 2021, with the government's R&D budget expected to exceed 30 trillion won by 2023. The 2023 budget of MSIT, the main government department for science and technology, also increased by 2.3% from the previous year to 18.4 trillion won. This ongoing investment in science and technology has also led to an increase in the number of researchers, which exceeded 580,000 individuals in 2021. When calculated based on South Korea's population, this number is remarkably high, with both the FTE per 1,000 people in the workforce and the FTE per 1,000 population ranking first worldwide.

Bold investment in science and technology is the first step in developing and retaining a large number of science and technology talents, including researchers, in the field of science and technology.

(2) Strategies for and Development of Science and Technology Specialized Universities Focused on Research

As mentioned in 3.2.1, science and technology specialized universities, including KAIST, GIST, DGIST, and UNIST (but excluding POSTECH), were established based on special laws[68] and are under the jurisdiction of the MSIT, not the Ministry of Education. They are higher education institutions dedicated to fostering advanced science and technology talent and conducting research in science and technology.

POSTECH is a private university established with the support of POSCO, a major corporation. Therefore, compared to comprehensive universities, science and technology specialized universities are financially very affluent, receiving substantial support from the national government. Also, because they have fewer students, they offer substantial support per student, a distinguishing feature. This allows undergraduates and graduate students to study and research with almost no economic burden, enjoy generous scholarships, and participate in English summer programs abroad through support funds. They also ensure their faculty members are high-quality and provide sufficient time for research even to these faculty members. English is mandated in schools, and lectures are conducted entirely in English. As a result, the English proficiency of South Korean students is said to be very high. Such substantial student support and research support have resulted in many research achievements, attracting attention both domestically and internationally.

Japan has four national or equivalent graduate universities in the natural sciences: The Graduate University for Advanced Studies (SOKENDAI), the Okinawa Institute of Science and Technology Graduate University (OIST),

[67] See Cabinet Office "Expected Benefits of Science, Technology, and Innovation Investment". https://www5.cao.go.jp/keizai-shimon/kaigi/special/reform/wg7/20201030/shiryou2_4.pdf

[68] The Korea Advanced Institute of Science and Technology (KAIST) was established under the KAIST Act, the Gwangju Institute of Science and Technology (GIST) under the GIST Act, the Daegu Gyeongbuk Institute of Science and Technology (DGIST) under the DGIST Act, and the Ulsan National Institute of Science and Technology (UNIST) under the UNIST Act.

the Japan Advanced Institute of Science and Technology (JAIST), and the Nara Institute of Science and Technology (NAIST). To be precise, OIST is a special private university funded by the Japanese government. However, it is considered equivalent to a national graduate university here since it is almost entirely funded by government grants. While these universities share the characteristic of being research-focused with South Korea's science and technology specialized universities, unlike South Korea, all four do not have undergraduate programs. It's worth noting that GIST and DGIST initially did not have undergraduate programs either, but as the institutions' renown and popularity grew due to their research achievements and the increase in budget from MSIT, GIST began undergraduate admissions in 2010, and DGIST in 2014.

Another shared factor between science and technology universities in South Korea and Japan is their elite orientation with relatively few students but abundant budgets, which produces many research achievements. For instance, OIST produced research outcomes equivalent to top-class global research institutions within a decade of its establishment, as indicated in the 2015 to 2021 NATURE INDEX[69]. In the 2019 NATURE INDEX, when the proportion of articles published in high-quality scientific journals was normalized for scale, OIST ranked 1st in Japan and 9th in the world[70]. OIST maintains a high level of instructional quality by keeping a low professor-to-student ratio of about 1:3, and over half of the students and faculty are international. This is a significant difference from South Korea's science and technology specialized universities. Although there are international students enrolled at South Korean science and technology universities, the overwhelming majority are still domestic students. Compared to Japan, South Korea's science and technology specialized universities boast a high profile domestically, rivaling comprehensive universities due to their long histories[71].

We will next examine GIST and UNIST's research strategies and achievements.

GIST[72], an institution that prides itself on its selectiveness, was originally a graduate-only institution since its opening in 1995 but began offering undergraduate programs in 2010 and now operates with about 200 faculty members, approximately 800 undergraduates, and about 1200 graduate students. GIST is known for providing substantial research support to its faculty, providing "startup funding" to all new faculty members, and exempting them from performance evaluations for the first year to focus on consolidating their research. If desired, they can also be exempt from lecturing in their first year. For professors, the teaching load is two courses per year, but those leading large research projects are exempt from teaching. The proportion of foreign faculty members is maintained at about 8-10%, and high-level researchers are being invited to promote collaborative research. Continuous efforts are made to ensure global competitiveness, with lectures conducted in English from the outset and the use of English mandated. Undergraduates who meet the required English grades and have never received an F grade or disciplinary action can participate in summer programs at the University of California, Berkeley, Boston University, etc., through support funds (7 million won per person, almost all participate annually). Outstanding undergraduates can go on exchange to

69 NATURE "The power of borderless research" https://www.nature.com/articles/d42473-021-00382-2

70 NATURE "Top 10 academic institutions in 2018: normalized" (2019) https://www.nature.com/articles/d41586-019-01924-x.

71 All of Japan's graduate universities of science and technology were established after 1990.

72 For more on GIST, see: https://www.chosun.com/site/data/html_dir/2018/11/12/2018111200654.html
https://www.chosun.com/site/data/html_dir/2016/09/06/2016090600272.html
https://www.chosun.com/site/data/html_dir/2019/11/27/2019112700099.html
https://i-mentor.tistory.com/252; https://www.gist.ac.kr/kr/img/sub05/faculty_handbook_dw01.pdf

California Institute of Technology, University of California, Berkeley (expenses paid by the university). For graduate students, master's and PhD theses must be in English only, and PhD students must have published as lead authors in SCI journals to graduate. All graduate students are involved in their advisors' research. Undergraduates can also participate in graduate research labs if they wish.

Tuition is essentially free for GIST graduate students[73]. However, if they cannot graduate within 2 years for a master's program or 4 years for a PhD program, they receive no support after that point and must pay full tuition. This policy is in place to encourage efficiency and focus on research. Thanks to such comprehensive research support systems, GIST recorded 4th place in the world in the "citations per faculty" indicator, which measures research strength, in the 2020 QS World University Rankings, and has been ranked top in the country for 13 consecutive years[74]. In 2021, its external research funding was 142.4 billion won, and research funding per faculty member reached 760 million won[75]. These indicators reveal GIST's high level of research strength (research outcomes) and its solid foundation for securing research funding.

Ulsan National Institute of Science and Technology (UNIST)[76] is a research institution with strong research capabilities, having ranked top domestically for six consecutive years in the Leiden Ranking, (which evaluates mainly the quality of papers). From 2019 to 2021, it has had 6 to 7 researchers ranked annually as the world's most influential (top 1% by citations). Among the 2,460 papers it published from 2017 to 2020, 335 papers (13.6%) are in the top 10 by citations, drawing significant attention for its remarkable research achievements. UNIST operates mainly on integrated master's and PhD programs for cultivating research talent[77], conducting all classes in English. Scholarships are provided to all undergraduate and graduate students (130,000 won per month, with an additional 800,000 won for master's students and 1,100,000 won for PhD students per month), and it is said that there are many other scholarships available, making the burden of tuition almost nonexistent. For undergraduate students, the program structure includes management and science and engineering (admission is without a major). Science and engineering students choose their major in the second year. From an investment of 70 billion won at its opening in 2015, a research support headquarters was established to provide the best possible research environment for faculty and graduate students. In the faculty evaluation system, publishing research results in journals within the top 7% of impact factor (IF) is a mandatory requirement for tenure, and UNIST is known for evaluating the number of citations over the number of papers when promoting faculty.

Support for PhD students is improving in Japan, with initiatives like the 10 trillion-yen fund[78]. However, support for master's students is still insufficient beyond loans and scholarships. Substantial support for young researchers is a must for strengthening research capabilities, which requires long-term and stable support. Furthermore, universities need to focus on improving their research capabilities and international competitiveness by creating an environment

73 The entrance fee is just 680,000 won. A master's takes 2 years and PhD 4 years. Academic scholarships, meal subsidies, and research incentives are provided, making it essentially free of charge.

74 https://www.chosun.com/site/data/html_dir/2020/06/10/2020061003434.html

75 https://www.hankyung.com/society/article/202112291153h

76 UNIST: https://www.kookje.co.kr/news2011/asp/newsbody.asp?key=20170628.22011193149; http://www.ujeil.com/news/articleView.html?idxno=306756; http://news.heraldcorp.com/view.php?ud=20220113000023

77 As of 2020, it has 2,076 undergraduates, 492 master's students, 268 PhD students, and 1,117 in the integrated master's and PhD program.

78 On November 15, 2022, the Ministry of Education, Culture, Sports, Science and Technology announced a basic policy to provide grants to internationally outstanding research universities from the profits of the 10 trillion yen university fund.

conducive to research, improving various systems, and focusing on English education.

(3) Developing practical skills and solving problems with postdoctoral positions

The development of practical skills, especially in the era of the Fourth Industrial Revolution[79], is a focus of the South Korean government. As mentioned in 3.2.2, South Korea had a period when the talents developed by universities did not match those needed by companies, and as a solution, actively introduced contract departments and promoted employment in companies for graduate students and postdocs.

Contract departments, established by universities in South Korea to match the country's actual conditions, played a decisive role in the country's success through industry-academia collaboration. These departments have been an effective strategy, achieving three goals: alleviating the shortage of personnel in cutting-edge fields of science and technology, producing personnel already equipped with skills needed by companies, and improving the employment rate of students. Despite initial concerns, many universities and companies have collaborated to establish the numerous contract departments available today. These departments are not limited to semiconductors and mobility but also include AI and cybersecurity. They have also been highly evaluated by many companies and students. Small and medium-sized enterprises have been implementing early employment type contract departments that allow for employment after three years of study, advancing a talent acquisition strategy that leverages their own characteristics and strengths.

The government's provision of necessary training for graduate students and postdocs, enabling them to quickly adapt to corporate work, is another effort to effectively utilize talent. Companies, especially small and medium-sized enterprises, face challenges in securing high-level research personnel capable of handling R&D who can also handle corporate operations. Solutions to these kinds of problems are commonly left to the companies themselves, so it is rare for a government to actively tackle this issue. The cooperation between the government and companies has increased the entry of PhD students and postdoctoral researchers into companies and alleviated the concentration of talent in universities and research institutions. The increase in PhD and postdoctoral researchers employed by companies is also securing positions.

The issue of securing positions is crucial for providing researchers with an environment where they can conduct research with peace of mind. Innovation and scientific and technological achievements can only arise when environments dedicated to research are available. It is vital for the government to establish such systems so that companies, and not just universities and research institutions, can actively engage in developing research personnel.

(4) Expanding support for female researchers and increasing their proportion

Another area that Japan can learn from is the support measures for female scientists and researchers.

Like Japan, South Korea is an advanced country with a very low proportion of female researchers[80]. However, while Japan has only seen an increase of about 3.7% in its proportion of female researchers from 2011 to 2021, South Korea has seen a 4.5% increase. A major difference between the support policies for female researchers in South Korea and

79 For details, see https://spap.jst.go.jp/korea/experience/2022/topic_ek_17.html, specifically the column on science and technology in South Korea during the Fourth Industrial Revolution.

80 See WISET "Study of Overseas Examples for Supporting Diversity in Human Resources and the Expansion of Growth Support for Female Researchers in the Field of Science and Technology".

Japan is that South Korea has formulated a long-term policy (basic plan) focusing on female scientists and engineers and has a large national organization dedicated to supporting female scientists and engineers. By comparison, Japan lacks a basic plan and an organization of this scale.

In Japan, the Act on the Promotion of Women's Active Engagement in Professional Life was enacted in 2015, and the Fifth Basic Plan for Gender Equality[81] in 2020 emphasized the promotion of hiring and appointment of women in the fields of science, technology, and academia, and improvement of research capabilities.

The Sixth Science, Technology, and Innovation Basic Plan[82] in 2021 set goals to increase the proportion of newly hired female researchers by 2025: 20% in the sciences, 15% in engineering, 30% in agriculture, 30% combined in medicine, dentistry, and pharmacy, 45% in humanities, and 30% in social sciences. It also aimed to rapidly increase the proportion of women among university faculty (presidents, vice presidents, and professors) to 20% and to 23% by 2025.

In 2023, the Ministry of Education, Culture, Sports, Science, and Technology (MEXT) launched the Initiative for Realizing Diversity in the Research Environment[83] program. This initiative supports universities and other institutions in their efforts to achieve diversity by integrally promoting the balance between research and life events such as childbirth and childcare and developing leaders among female researchers through the enhancement of research capabilities.

As previously mentioned, South Korea establishes a basic plan for supporting the development of female scientists and engineers every five years, setting goals for the next five years.
The Fourth Basic for 2019-2023 sets the following goals.

81 See: https://www.gender.go.jp/about_danjo/basic_plans/5th/index.html.

82 See: https://www8.cao.go.jp/cstp/siryo/haihui053/siryo1.pdf

83 See: https://www.mext.go.jp/a_menu/jinzai/lifeevent/1422080_00005.htm.

Table 4-1 Results Indicators for the Fourth Basic Plan for Supporting the Development of Female Scientists and Engineers

Field	Goals to be achieved	Level of achievement (as of 2021)
Development and growth in science and engineering	Increase the rate of female students enrolling (university) in engineering[84] to 30%	24.5%
	Increase the employment rate in science and engineering[85] to 70%	58.2% [86]
	Develop 3,000 female talents in new industrial fields (cumulative)	2,748 people
Promotion of active participation and economic activity amongst women	Increase the proportion of women in regular jobs in the science and technology R&D field to 30%	17.7%
	Achieve a 70% economic participation rate for female scientists and engineers in their 40s	63.9%
	Increase the proportion of women in R&D evaluation expert teams	The proportion of women in committees under the jurisdiction of MSIT is 42.5% (Overall projects): 7.1% (2011) -> 11.4% (2020) (Large research projects over 1 billion won): 5.6% (2011) -> 7.7% (2020)
Prepare systems, infrastructure, and environment	Increase the proportion of female managers in public institutions and institutions related to science and technology R&D to 20%	Public institutions: 22.5% Science and technology research and development-related institutions: 12%
	Create an environment conducive to female scientists and engineers	Conduct a survey on the actual use of female scientists and engineers, creating indicators for establishing work-friendly environments.
	Realize gender innovation in R&D	Amend the Basic Act on Science and Technology to reflect gender specificity. Added to the evaluation criteria for national R&D projects from 2023.

Such clear goals and indicators are leading to a steady increase in female researchers in the field of science and technology.

Data from the past decade shows that the proportion of female university students enrolling in science and engineering increased from 18.7% in 2010 to 24.5% in 2021. The proportion of women who are full-time equivalent in

84 Engineering refers to majors related to architecture, civil engineering, urban planning, mechanical engineering, metallurgy, electrical engineering, electronics, precision instruments, energy, resources, materials, computing communication, industry, chemical engineering.

85 Science and engineering are a general term for engineering and science, where science includes fields of study such as mathematics, physics, chemistry, life sciences, earth sciences.

86 The rate for male university students was 64.7%.

the field of science and technology also increased from 11.4% in 2010 to 17.7% in 2021. Although the target of 30% is still a way off, it is undeniable that the trend is increasing.

The number of female scientists and engineers in research and development increased from 33,991 in 2009 to 54,201 in 2020, showing an increase in activity amongst female researchers. The proportion of female researchers is gradually increasing in both Japan and South Korea, but the rate of increase is greater in South Korea. Japan saw an increase from 13.8% in 2011 to 17.5% in 2021, a 3.7% increase, whereas South Korea increased from 17.7% to 22.2%, a 4.5% increase.

The existence of a large government-affiliated support organization for female scientists and engineers is also noteworthy. The Center for Women in Science, Engineering, and Technology (WISET) provides support activities for a wide range of women, from elementary, middle, and high school students to female researchers aiming to return to their careers.

Under the Korean Federation of Women's Science and Technology Associations (KOFWST), there are 78 women's support organizations, including a woman in science and technology committee and a science and technology promising talent network, each supporting female scientists and engineers. It's difficult to confirm how much these support organizations have contributed to the advancement of female scientists and engineers, but the presence of numerous organizations that female scientists and engineers can rely on is evidence of high societal interest in their advancement and is surely contributing to the increase in female researchers.

Traditionally, the number of men in science and engineering has been higher than that of women, and career discontinuation due to childbirth and child-rearing presents numerous barriers for women. Japan may need more proactive government support and goal setting to resolve issues related to women's advancement.

(5) Support for outstanding international talent and international students

Lastly, among South Korea's strategies for securing and developing scientific and technological talent, an area that Japan can consider adopting is support measures for outstanding foreign researchers and international students. As global competition intensifies, countries are seriously engaging in securing foreign researchers and international students.

Sections 3.5 to 3.6 introduced South Korea's efforts in securing and supporting outstanding foreign researchers and international students, providing not only research support but also substantial support for living in Korea. These services make it easier for researchers to settle in South Korea. Researchers receive annual salaries and incentives, opportunities to learn Hangul, consideration for their spouses' employment and their children's education, making it appealing for their whole family to live comfortably in South Korea. Additionally, the visa system has been improved multiple times, and activities outside of visa qualifications follow a negative list approach (anything not prohibited is allowed), meaning there are virtually no restrictions on work or daily life. For high-level foreign researchers, the requirements for obtaining permanent residency or naturalization in South Korea have been significantly relaxed[87], and the policy now allows for dual citizenship.

Furthermore, the emphasis on English education and the increase in universities mandating English for instruction have established an environment conducive to foreign researchers' work.

The South Korean government actively incorporates feedback from foreign researchers and has established support services and platforms to assist with daily life and with applying for R&D projects. This indicates the importance of continuously listening to researchers’ opinions and making improvements, instead of trying to design perfect systems.

Economic benefits for foreign researchers and an increase in projects that they can participate in are basic elements for attracting talent, and it is necessary to enhance support in terms of visa issues, family, life, and language. In Japan, similar to South Korea, support for researchers, not only in terms of research but also their lives and families, has been actively provided and enhanced over the past few decades by various entities including universities, research institutions, local governments, and research support organizations. This comprehensive support is also reflected in the policy formulation of relevant ministries and agencies. However, as demonstrated in this paper, substantial support has been provided in South Korea and around the world, especially in non-English speaking regions. This reaffirms that preparing environments is a crucial factor in competing for researchers. It is also important to continually improve and enrich these efforts from their perspective.

Regarding international students, section 2.5 showed that the number of international students aiming for degrees increased even during the COVID-19 pandemic, and the number of non-degree students was not significantly affected. This indicates that South Korea’s key to success was quickly changing the direction (target countries) of student recruitment due to changes in the international situation, moving away from heavy reliance on China. The ability to respond to changes in a timely manner and work on new strategies is one of the country’s significant strengths.

Even during the pandemic, online platforms were used for regular recruitment activities and promoting South Korea, leading to a significant increase in students from Vietnam, Mongolia, Uzbekistan, and France. The influence of the wave of Korean culture cannot be ignored as an aspect in the increase in international students, but it seems that the efforts of the universities and the government have also played a significant role. To prevent a loss of international students during the pandemic, each university swiftly switched to online classes and built a solid platform for online classes, in addition to enhancing mental care for current students and support related to life, study, and employment, thereby strengthening the support system so that international students could live in South Korea with peace of mind. Thanks to this, there was no rush of international students returning to their countries, preventing a sharp decrease in their numbers due to COVID-19. To secure large numbers of outstanding international students, scholarships were enriched, and counseling and support for employment were strengthened to have these individuals continue to contribute to society by working in Korean companies. The visa system was also improved so that they could stay even if they could not find a job immediately. Through providing detailed support in all aspects of life, including from

87 The Ministry of Justice introduced a fast-track system for permanent residency and naturalization of scientific and technological talent in December 2022, aiming to encourage outstanding foreign scientific and technological talents to settle in South Korea. This policy allows master's and PhD students affiliated with the four Institutes of Science and Technology (KAIST, Gwangju Institute of Science and Technology, Ulsan National Institute of Science and Technology, Daegu Gyeongbuk Institute of Science and Technology) and the University of Science and Technology (UST) to obtain permanent residency or naturalize without employment, after living in South Korea for three years post-graduation and allows for dual citizenship. (Note: Although the evaluation uses a point system, the main criteria include educational background, research achievements, research history, and proficiency in Korean, so the conditions are generally met unless fraudulent research is uncovered) See https://spap.jst.go.jp/korea/experience/2023/topic_ek_02.html for reference.

study to employment, the number of international students in South Korea has been on a stable increasing trend.

International students are valuable talent from Japan's perspective when it comes to global competition and the country's declining population. It is, therefore, necessary to make efforts towards promotional and recruitment activities to enable the recruitment of international students from all over the world without relying on specific countries. Using Japan's culture and traditions in promotional activities might be one way of achieving this goal. In Japan, a high-level talent points system[88] has been introduced for visa issuance to help attract these individuals. However, this system is for those who are already employed, and the types of visas for outstanding international students are still relatively basic. Improving the visa system to make it easier for high-level international student talent to come and stay in Japan might also be of importance. It is also desirable to devise methods to provide comprehensive and delicate care and support for international students, along with the establishment of an infrastructure for on- and off-line hybrid class systems to become more firmly established.

Study and training amongst Korean students in top universities in America has been strongly promoted, especially in universities specialized in science and technology. Examining the number of research doctorate holders from other regions in America between 2010 and 2019, Japan's numbers decreased by 45%, the most among major countries, due partially to the impacts of its declining birthrate. However, South Korea has managed to limit its decrease to 16%[89]. It's vital to cultivate a certain number of domestic talents as international students in top universities in the United States and other major countries leading in science and technology. From this perspective, the approach of South Korea's specialized science and technology universities can be considered a valuable reference.

Considering the points raised, it's worth noting that in Japan, under the guidance of relevant government ministries and agencies, there has been significant implementation of support measures for international students. These efforts, which focus on both quality and quantity, are primarily carried out by universities and the Japan Student Services Organization. However, as demonstrated in this paper, South Korea and other countries are intensifying their efforts to attract international students, and the competition for acquiring talented foreign students is becoming increasingly fierce. It's crucial to continuously enhance support measures for international students, considering changing international dynamics and situations like pandemics, while also learning from South Korea's example to make ongoing improvements.

88 For details, see: https://www.moj.go.jp/isa/publications/materials/newimmiact_3_system_index.html

89 "Strategy on International Expansion of Science and Technology," Council for Science, Technology and Innovation, International Strategy Committee, March 30, 2022

5 Summary

This paper has examined various policies and projects for the cultivation and retention of science and technology talent in South Korea.

South Korea is a country that places great emphasis on science and technology, to the extent that the constitution mandates that the state makes effort in innovation in science and technology. It has also not neglected the establishment of basic plans related to science and technology. The South Korean government establishes new basic plans for science and technology, cultivation and support of science and technology talent, cultivation and support of female science and technology talent every five years. Based on these clear goals and plans, the country has steadily cultivated and secured its science and technology talent.

With public-private cooperation, efforts are continuing to develop policies and projects that best fit South Korea's actual situation, from domestic training of young researchers to training personnel with practical skills needed by companies and industries. Thanks to these attempts, many scientific and technological achievements have been produced, centered around universities specialized in science and technology, and its numbers of world-top-level researchers continues to increase. The introduction of contract departments in collaboration between universities and companies has also eased the post-doctoral dilemma for young researchers and the shortage of personnel with practical skills in advanced technology fields.

Regarding female science and technology talent, the MSIT has established support centers under its umbrella, continuously providing broad support for female researchers and contributing to the creation of a society where female researchers can more easily play an active role. Through the government's support policies and the substantial support of large support centers, the number of female college students entering science and engineering fields has increased, and the number of women who return to the field after childbirth and childcare has also increased. WISET provides a wide range of support services, including support for funding projects, support for research institutes' recruitment costs, and one-on-one counseling, and is relied upon by many female researchers.

In terms of foreign talent, in addition to visa improvements and considerations regarding research and living environments, proactive deployment of projects such as the BRAIN POOL project has attracted outstanding talent from around the world. Even in the tough situation of the COVID-19 pandemic, South Korea did not give up on recruiting international students, and ongoing promotional and recruitment activities were carried out worldwide, preventing a decrease in the numbers. Thanks to fully leveraging South Korea's strengths, such as the power of Korean culture, and deploying recruitment activities for international students in countries like Vietnam and Uzbekistan, the number of international students aiming for degrees continued to increase despite the COVID-19 pandemic. In addition, by leveraging its strengths in digital infrastructure, after the outbreak of COVID-19, infrastructure for online classes was rapidly established, providing high-quality classes and preventing the loss of international students.

It is making continuous and stable investments in science and technology, and developing talent to win on the global stage, welcoming an era of 100 trillion won in research and development expenses. South Korea, which has the highest number of researchers relative to its population, is seriously committed to securing talent, which is the core of its national competitiveness. Japan, too, must continue to work on efforts toward bold investments in science and technology, resolving the issues surrounding positions for research talent, and support for female researchers.

Population decline due to its aging society is also a serious issue for Japan, and the government needs to actively initiate and work on systematic support policies and measures for securing female researchers and foreign talent without relying solely on the private sector's efforts and investments. To attract foreign talent and international students, who themselves are valuable sources of talent, it is important to create an environment in Japan where they can be more active. Measures should involve everything from reviewing visa systems to arranging research environments and providing detailed support for students to become established in Japan.

It is hoped that South Korea’s efforts in securing and cultivating science and technology talent introduced in this paper will be of some help to Japan's future talent cultivation projects and serve as foundational material for promoting international cooperation between Japan and South Korea and understanding of South Korea's science and technology projects.

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Additional cooperation for the investigation was provided by members of the JST Human Resources Department, the Science and Technology Innovation Talent Education Division & Diversity Promotion Office, and the Management Strategy Department of the National Museum of Emerging Science and Innovation.

We would like to thank everyone involved for their kind assistance.

Research Report

APRC-FY2022-RR-05

Research on Nurturing and Maintaining STI talents in South Korea

Published March 2024
ISBN 978-4-88890-919-8

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