# ASIAN REGION

# Graduate Education Reforms and International Mobility of Scientists and Engineers in China

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## Historical Sketch

China is a nation with a long history of an ancient higher education system, and a shorter period with a more modern one. Compared with the leading Western nations, the process of development of Chinese graduate education has been convoluted. Its modern stage can be traced to 1902, when the Qing Dynasty government issued the first official regulations for a modern educational system, which stipulated the establishment of a Grand School (graduate school) above the existing undergraduate education system. During the period 1911-34, the government made numerous efforts to establish the academic degree system, which finally came into being as a result of these efforts in 1935. However, due to World War II and the Japanese intervention of 1937-45, the Regulations on Degree Conferment, aimed at improving education and science in China, were not fully implemented. For the 14-year period between 1935-49, only baccalaureate degrees and 200 master's degrees were granted—not a single doctoral degree was awarded (B. Wu 1993). The training of graduate students took place largely in foreign countries.

After the founding of the People's Republic of China (PRC) in 1949, the communist government abolished the academic degree system; it was not reestablished until 1981. During the period from 1949-65, before the Cultural Revolution occurred in 1966, only about 20,900 students graduated from the Soviet-pattern graduate schools that had been established (Guo 1998). As the old academic degree system had been abolished earlier, not one of these students was actually granted a graduate degree.

The Cultural Revolution led to a 12-year suspension of graduate enrollment. This resulted in a great loss to higher education institutions. When the Cultural Revolution ended in 1976, the number of full professors had decreased by 25 percent as compared with 1965, associate professors by 19 percent, and lecturers by 6 percent (MOE 1985). In the first years after graduate education was resumed in 1978, the shortage of high-level scientific and educational personnel and the low quality of teachers was evident everywhere in China. During the Cultural Revolution alone, China had lost 1.5 million specialists (Chen 1992). It has been estimated that the Cultural Revolution set China's socioeconomic and scientific development back about 20 years (Min 1997).

Subsequently, Chinese leaders became aware of the correlation between high-level specialized personnel and the realization of their ambitious "Four Modernizations" (of industry, agriculture, science and technology, and national defense). With the new national policies for reform, as well as the opening up of the country to the outside world in 1978, the Chinese government resumed graduate education in China and gave priority to its development. Within a short period, Chinese graduate education experienced notable development, which has attracted international attention. In terms of enrollment and output, between 1978-94, 460,000 graduate students had been admitted—nearly 20 times the number (23,400) for the 17-year period between 1949 and the beginning of the Cultural Revolution in 1965 (Z. Wu 1995). Between 1978-97, 430,000 graduate students (including 390,000 master's degree and 34,000 doctoral degree) had graduated, over 20 times the number (20,900) graduated prior to the Cultural Revolution (Zhang 1998).

## Current System

The existing higher education system in China basically derived from the Soviet model, and its pattern of governance is still a prominent force in its impact on the universities. In recent years, however, Chinese higher education has been shifting from a rigid model of state control to a model of state supervision that is more in accord with the transformation from a planned to a market economy.

Before focusing on the administrative structure of graduate education, two important features that are derived from the Soviet model and that characterize Chinese higher and graduate education need to be understood.

- **Within and Without Research Institutions.** Unlike undergraduate education, which is exclusively carried out in institutions of higher learning, graduate education in China is undertaken by both institutions of higher learning and research institutes outside universities. This is due to the traditional division of teaching and research between universities and research institutes. Currently, these institutions of graduate learning can be divided into four categories in terms of type of control and sources of funding.

- Thirty-six key comprehensive, polytechnic, and normal institutions are administered directly by the State Education Commission (SEdC),[1] which is also responsible for the overall guidance of the higher and graduate education system in China by formulating policies, decrees, and plans. Many of them are prestigious, pace-setting institutions, with broad scope in both undergraduate and graduate education.

- Over 400 specialized institutions and research institutes are under the control of central ministries like the Ministry of Agriculture, Ministry of Public Health, etc., and specialize in training personnel for their sponsoring ministries, with emphasis on national needs.

- About 100 provincial-level institutions and research institutes are governed by provincial educational commissions (or bureaus) and commissions for science and technology. Most have a relatively small number of graduate students.

- There are also 130-odd research institutes and a few other institutions of higher learning affiliated with the Chinese Academy of Sciences (CAS) and the Chinese Academy of Social Sciences (CASS); these are traditionally focused on basic research.

To maintain standards in degree courses, only selected universities and research institutes have been authorized to grant degrees. According to 1996 statistics, there were a total of 1,054 institutions of higher education in China (DFA 1996), of which only 471 institutions of higher education and 315 research institutes were authorized to grant graduate degrees. The majority of these were under the jurisdiction of the SEdC, the central ministries, or the CAS/CASS.

- **Division of Authority for Academic Matters.** American universities generally operate under the authority of state governments to grant accredited degrees and enjoy substantial autonomy (Johnstone 1993). In China, authority for graduate admissions, training, management, and the formulation of degree standards is shared by two state administrative organs—the SEdC and the Academic Degrees Committee (ADC) under the State Council[2]—operating in parallel. Both have their own corresponding vertical administrative structures and exercise somewhat different responsibilities and authorities. Generally speaking, the former has a more executive function, while the latter has a more legislative function. A brief description of their respective structures and functions follows.

## Administration of Graduate Education

China has a three-level graduate education administrative system, with the SEdC at the top; the education commissions and bureaus of higher education under the central ministries, provinces, and the CAS at the middle level; and the training institutions and research institutes at the base.

- The SEdC exercises unified leadership over graduate education in the country and is responsible for macro-level guidance and administration.

- The middle-level administrative entities are responsible for administering graduate education in the institutions of higher learning under their respective jurisdictions.

- At the micro-level, the president/director, or one of the vice presidents/directors, of the university or research institute takes charge of the work of graduate education. An administering body, such as a graduate school, graduate department or di-

[1] Before 1985, this institution was called the Ministry of Education, and recently—in March 1998—it reverted back to this title.

[2] The State Council in China is comparable to the U.S. cabinet or to a council of ministers.

vision, or graduate section, can be set up to do the daily administrative work in accordance with the scope of graduate education and actual needs.

## Administration of Academic Degrees

Similar and parallel to the administrative system of graduate education, a three-tiered administrative structure has been applied in the management of academic degrees: the ADC is at the top; the central ministries and commissions, CAS/CASS, and provinces are at the middle; and the degree-granting institutions (including both universities and research institutes) are at the bottom of the system.

- The ADC was set up under the State Council in December 1980 to supervise the conferring of academic degrees all over the country. Its main duties include formulating national guiding principles and policies for academic degree work, examining and approving graduate degree-granting universities and research institutes, and certifying disciplines and specialties as well as doctoral supervisors.

- The ministry- and provincial-level degree administrative agencies take charge of the degree work under their own jurisdictions. Their main responsibility is to coordinate work within the scope of their own authority and to provide additional funding for key and urgently needed degree programs.

- An academic degree evaluation committee is established in each degree-granting institution as a leading agency responsible for the quality of degree work and granting of degrees.

By the middle of 1998, the ADC system had accredited 633 institutions to confer master's degrees in 8,248 disciplines and specialties, 229 institutions to confer doctoral degrees in 2,292 disciplines and specialties, and more than 10,000 doctoral supervisors (Chisa 1998).[3]

Thus, the SEdC takes charge of developing the basics of graduate education, graduate teaching, and research training, while the ADC has responsibility for checking and accepting the resulting "products"—the graduate programs and graduates—in accordance with ADC standards.

[3] In Chinese universities and research institutes, only disciplines (somewhat similar to disciplinary programs) and specialties of relatively high quality in terms of teachers, research facilities, and reputation are authorized by the ADC system to offer graduate courses and grant graduate degrees.

## Finance

There are two major sources of funding for higher education in China: state appropriations, the major source, accounting for more than 80 percent of the total; and income generated by higher education institutions and research institutes themselves, which has been increasing in recent years. The allocation for the 36 national universities administered by the SEdC and the specialized institutions and research institutes under the control of central ministries and the CAS comes from the budget of the Ministry of Finance. The local universities and research institutes receive funds mainly from provincial finance departments.

There are other funding sources for graduate training and research activity. One fund allocation is from the Ministry of Finance and is based on a head-count enrollment. Another is from a variety of research foundations, such as the Chinese National Science Foundation. A third source is from contract projects.

Since the late 1970s, China has increased its allocation to higher education both in absolute terms and relative to government expenditure and gross national product (GNP). Total public expenditure increased 4.76 times, from 111.10 billion yuan in 1978 to 528.74 billion yuan in 1993; expenditure on higher education increased 10.0 times, from 1.50 billion yuan to 15.05 billion yuan, during the same time period (Min 1997). This reflects the high priority given to higher education in the country's modernization process.

# Degree Structure

As in America, the levels of academic degrees in China are connected to different phases of higher education. There are three categories of official degrees: bachelor's degrees, master's degrees, and doctoral degrees.

## Bachelor's Degree

Precollege education in China consists of 12 years. By taking national entrance examinations, senior high school graduates are enrolled for their college studies.

The average length of an undergraduate program is 4 years, with 5-year programs offered in a number of specialties in science universities. Medical universities provide 5- or 6-year undergraduate programs. Students who complete all requirements of the curriculum receive a bachelor's degree.

## Graduate-Level Degrees

China's graduate education has two official levels—the master's degree and the doctoral degree. At each academic level, two kinds of people are trained to meet the country's different needs: academic personnel and applied science personnel. There are full-time and part-time graduate programs; the latter require from 1 to 3 years of additional study.

**The Master's Degree.** By passing graduate entrance examinations, those who hold bachelor's degrees or equivalent academic qualifications can pursue 2- or 3-year master's programs.[4] Master's degrees are conferred upon those who have passed certain prescribed courses, including written examinations; written and defended orally a thesis presenting original views on a designated research theme; have a firm grasp of basic theories and systematic knowledge of the relevant field; exhibit good command of a foreign language; and are able to conduct scientific research or specialized technical work independently.

In recent years, in addition to this regular path of earning a master's degree, five other alternative channels have been developed, mainly for employed professionals and self-study applicants (ADC and SEdC 1995, Qin 1994).

**The Doctoral Degree.** By passing entrance examinations, those who hold a master's degree or equivalent academic qualifications can pursue 3- to 4-year doctoral programs. In addition, a small number of outstanding newly graduated bachelor's degree-holders can directly enter doctoral programs upon special recommendation. To receive a doctorate, students must pass written examinations in prescribed courses (usually including political theory, two foreign languages, and two to three specialized subjects) and conduct an oral defense of a dissertation. This must be accompanied by qualified records demonstrating that the student has a firm and comprehensive grasp of basic theories, systematic and profound knowledge in the branch of learning concerned, good command of two foreign languages, the ability to undertake scientific research independently, and the capacity to turn out creative achievements in science or specialized technology.

As with the master's degree, there is an alternative way for employed professionals to obtain a doctoral degree. This route is similar to the Japanese *Ronbun hakase*—earning a doctoral degree by submitting a dissertation without enrolling at a university. Matriculation and coursework are not necessary; submission of the dissertation suffices for the degree.

In terms of administrative structure and degree structure, the current Chinese degree system is something of a hybrid of the old Soviet system and the American system, combined with elements indigenous to China itself. Its administrative structure is more like the Soviet model, while its degree structure resembles that common in America.

## Expansion of Graduate Education

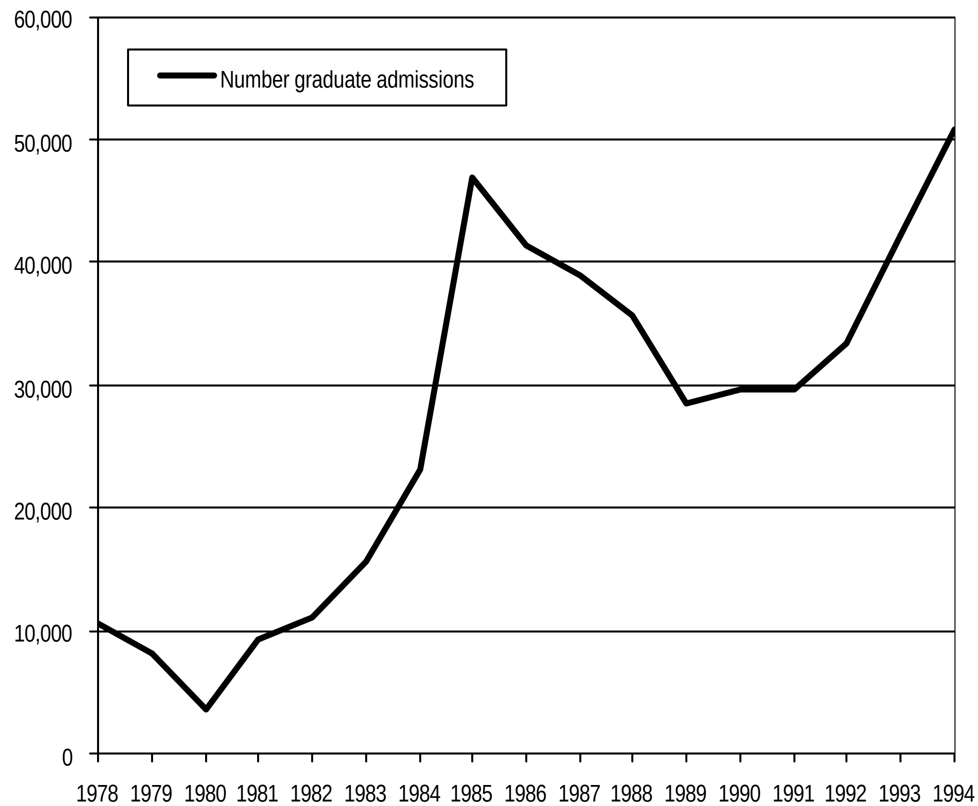
Since its resumption in China in 1978, graduate education has experienced a development that merits particular attention because it is not only unprecedented in China in terms of its speed and scale, but also rare in the history of graduate education internationally. According to available statistics, China spent 17 years increasing its graduate enrollment from 10,900 to 128,000 during the 1978-94 period; concurrently, America, Britain, Japan, and the former Soviet Union respectively spent 20, 29, 34, and 31 years reaching the same or similar developmental scale in their respective histories (Z. Wu 1995).

Figure 1 shows a number of significant fluctuations in Chinese graduate admissions. The admission decrease in graduate students from 1978-80 was related to the resumption of 4-year undergraduate education in China in 1977, following its suspension for 11 years. Before 1981, the main source of eligible applicants was from among those who had been admitted into 4-year undergraduate programs prior to the Cultural Revolution. As a great number of these students had matriculated in 1978-79, the number of qualified applicants in 1980 remained limited.

Between 1981-85, graduate education in China experienced a very rapid expansion due to a number of social, economic, educational, and scientific and techno-

[4] Usually the length for engineering and science programs is 2 to 2.5 years, while that for social science and humanities programs is 3 years.

Figure 1. Graduate recruitment in China, 1978-94




**SOURCE:** *Academic Degrees and Graduate Education,* 71 (6): 17, 1996. *Academic Degrees and Graduate Education,* 72 (1): 51, 1997.

logical factors. These changes occurred during a period when the Chinese government extended its new policy of reform and of opening its doors to the outside world beyond the economy and into many domains of society. The reflection of this first reform wave was clearly evident in the expansion of graduate education.

The total number of admitted graduate students in 1981 was 9,363—2.6 times as many as in 1980. This increase in admissions was due to two primary reasons: first, the establishment and implementation of the academic degree system in 1981 encouraged and attracted more people to pursue graduate studies; second, the first 4-year undergraduate program students who had entered college in 1977 graduated in 1981, thus adding to the pool of eligible and qualified graduate candidates.

Another big jump in graduate admissions occurred in 1984 and 1985. In 1985, 46,871 students were recruited, twice as many as in 1984. In turn, the accepted total in 1984 was 23,181, or 1.5 times as many as in 1983. This rapid growth was driven by landmark reforms in the economy, science and technology, and education:

- In 1984, a major reform document modifying the Chinese economic system was adopted—the "Resolution of the CPC [Communist Party of China] on the Reform of the Economic Structure," whose central argument was that the economy is activated only by relying on scientific and technological progress. Needless to say, a mammoth force of high-level specialized personnel would be needed to fulfill this task.

- The National Science Conference was held in March 1985, which advocated the promotion of strong linkages between research and teaching and led to the establishment of a new science fund—the National Fund of Natural Sciences—for which researchers in both universities and research institutes of the national academies are eligible to apply and with award decisions based on peer review. This reform legally and, to a certain degree, financially guaranteed higher education institutions a new role in research.

- In May 1985, the document "Decision on the Reform of the Education System" was approved by the CPC at the National Education Conference. Among the many policy changes set out in this document, the following two are of special importance concerning the development of graduate education: first, institutions were to be allowed to admit additional students on the basis of contracts with enterprises and other employers, and also to enroll fee-paying students; second, the credit system and double-degree studies were to be introduced.

- Starting in 1981, the World Bank undertook a 5-year program under which it would offer a loan of US$200 million, together with US$95 million from the Chinese government, to "strengthen science and engineering programs in 28 key higher education institutions by increasing graduate and undergraduate enrollments, improving the quality of graduate and undergraduate education and the ability to do university based research." This program played a significant role in improving the conditions and quality of both teaching and research and, especially, in expanding graduate enrollment in that period, for these key universities enrolled a large share of China's graduate students.

With strategic priority being given to education and research and relatively more financial investment coming in from the government and the World Bank in this period, approximately 379 new institutions of higher education were created between 1980-86—from 675 to 1,054; undergraduate student enrollment increased from 1,140,000 to 1,880,000. Graduate enrollment increased more than fivefold during the same period, rising from 21,600 to 110,371 (IAP and CRC 1991, DFA 1994).

With little experience in conducting graduate education, the Chinese government was confronted with a number of issues after 8 years of rapid development (1978-85). The phase between 1986-91 was characterized by frequent readjustment and various reforms in policies concerning the developmental scale and quality of Chinese graduate education. The total enrollment of 120,191 in 1987 transcended the capacity and resources available. Starting in 1986, following the SEdC's new directive on stabilizing scale, graduate admissions were gradually reduced to 35,645 in 1988, with a further large decline in graduate admissions in 1989, when only 28,569 were accepted—20 percent less than in 1988. This admission stabilization policy was continued by the SEdC in the subsequent 2 years. The reasons for the decline in graduate recruitment were complex. According to World Bank research findings, students' changing career goal patterns (more and more students wanted to go abroad or into joint ventures), the economic retrenchment policies of 1988, and the aftermath of the June 1989 events all had negative effects on graduate recruitment (IAP and CRC 1991).

## Distribution Across Graduate Degree Levels

In general, the distribution of levels of graduate degrees in a nation is determined and affected by a variety of societal factors. An ideal distribution of graduate degrees—the ratio between doctoral and master's degrees—should remain in accordance with the level of the country's national economic, scientific, and cultural development; population density; degree of universal schooling; and developmental status of its national education system. The appropriate ratio between these two degrees varies from nation to nation and from time to time. Some countries deliberately plan their ratio; others let market demand drive it.

In China, the government sets an annual ratio between doctoral and master's degree enrollment. During the 14-year period from 1982-95, China granted only 22,162 doctoral degrees, which is not commensurate with the country's vast population and the demands of rapid economic development. During this period, the number of doctoral degrees accounted for a very small share of the total graduate degrees awarded (table 1); the average ratio between master's and doctoral degrees over the period is about 14:1.

The rapid national economic development and the competition and challenge of science and technology in the 21st century call for high-level scientific and technical personnel. It is imperative that China pay more attention to doctoral education in the future. In view of China's current situation and future development, the ratio between master's and doctoral degrees should be raised to around 5:1 for a time. Such a ratio would seem reasonable given the existing circumstances in China, i.e.:

- In 1994, only 2.2 percent of full-time teachers in regular higher education institutions in China had earned doctor's degrees (Guo 1998).

| Table 1. Doctoral and master's degrees awarded and their ratio, 1982-94 | | | |
|---|---|---|---|
| Year | Master's | Doctorate | Ratio |
| 1981........... | 8,665 | 0 | 0 |
| 1982........... | 5,773 | 13 | 444.0:1 |
| 1983........... | 3,548 | 19 | 187.0:1 |
| 1984........... | 7,798 | 91 | 85.7:1 |
| 1985........... | 12,618 | 234 | 53.9:1 |
| 1986........... | 14,938 | 307 | 48.7:1 |
| 1987........... | 20,831 | 622 | 33.5:1 |
| 1988........... | 36,501 | 1,682 | 21.7:1 |
| 1989........... | 35,442 | 1,904 | 18.6:1 |
| 1990........... | 32,557 | 2,127 | 15.3:1 |
| 1991........... | 30,675 | 2,556 | 12.0:1 |
| 1992........... | 25,276 | 2,540 | 10.0:1 |
| 1993........... | 24,129 | 2,114 | 11.4:1 |
| 1994........... | 26,166 | 3,590 | 7.3:1 |
| 1995........... | 28,098 | 4,363 | 6.4:1 |

**SOURCE:** *Academic Degrees and Graduate Education,* 71 (6): 73, 1996. *Academic Degrees and Graduate Education,* 72 (1): 51, 1997.

- The former vice minister of the SEdC pointed out that as early as 1993 China had about 1 million senior specialized personnel; 80 percent of them will be retired by the year 2000, and the vacancies left by them will require a younger generation with advanced degrees.

- Due to the Cultural Revolution, China lost 1.5 million specialists. This resulted in an "inverse peak" in the 40- to 50-year range in the age structure of the faculty of higher education institutions. Those in their 40s are the smallest group, constituting only 14 percent of faculty members (Guo 1998).

- The rapid national economic development and competition and challenge of science and technology in the 21st century will doubtless require a mammoth force of high-level scientific and technical personnel.

- In China's ambitious development plan of higher education, a number of universities are to be transformed into world-class universities in the next century. One important feature of world-class universities is that they annually grant a large number of doctorate degrees and that the percentage of their faculty members with doctorates is very high—in some universities, as high as 100 percent. This can be clearly seen in a recent issue of *Asiaweek* (1997) which, based on its own evaluation, ranks Asia's top 50 universities. One important lesson from the ranking is that the relatively low percentage of faculty members with graduate degrees holds Chinese universities back.

Given these circumstances, it is imperative to pay more attention to doctoral education in the future. According to the Chinese development plan of graduate education, in the year 2000, graduate enrollment will be around 200,000. If 70,000 of these students graduate annually, given a ratio of 5:1 between master's and doctoral degrees, only about 14,000 will be doctorate recipients. In view of the current Chinese situation and the country's future development—as well as in comparison with the United States, where the corresponding ratio between annual master's and doctoral degrees is around 3:1—this number of doctoral degrees is far from what is really needed. China, aware of this situation, has already begun a "self-reliant" effort to generate doctoral degrees at home since the early 1990s.

## Field Distribution of Graduate Education

The current disciplinary distribution of graduate education in China is basically a reflection of the existing base, including graduate supervisors' academic specialties and expertise (Z. Wu 1997). One of its deficiencies is an asymmetry in major fields of study, primarily characterized by two features (tables 2 and 3). First, the proportion of traditional and basic disciplines such as history, literature, natural science, engineering, and medicine is too large—combined, these fields account for 82.2 percent and 78.9 percent of all doctoral and master's degree programs, respectively. Moreover, the master's and doctoral degrees awarded in these major fields of study from 1981-95 account for as much as 82.7 percent and 88.1 percent, respectively, of degree awards. Second, the proportion of newly emerging and applied disciplines, such as economics and law, which are badly needed in a market economy is too small—combined, these account for only 7.3 percent and 8.8 percent, respectively, of total doctorate and master's degree programs. Between 1981 and 1995, degree awards in these fields accounted for only 9.3 percent and 5.9 percent, respectively, of all master's and doctoral degrees awarded. This structure of major fields of study is aimed to serve the centrally planned economy; it by no means can respond to the growing demands for various types of high-level specialized personnel from a market economy. Thus, the Chinese government should strive to readjust the structure of major fields of study in its graduate education so as to develop a structure that is both internally coherent as well as externally responsive to labor market changes in the transition from a planned economy to a market economy.

**Table 2. Percent distribution of graduate programs by field of study, 1995**

| Field | Doctorate granting programs | Percent | Master's degree granting programs | Percent |
|---|---|---|---|---|
| Total | 2,398 | 100.0 | 8,467 | 100.0 |
| Philosophy | 41 | 1.7 | 170 | 2.0 |
| Economics | 109 | 4.5 | 374 | 4.4 |
| Law | 67 | 2.8 | 374 | 4.4 |
| Education | 40 | 1.7 | 214 | 2.5 |
| Literature | 115 | 4.8 | 599 | 7.1 |
| History | 75 | 3.1 | 224 | 2.7 |
| Sciences | 465 | 19.4 | 1,345 | 15.9 |
| Engineering | 863 | 36.0 | 2,906 | 34.3 |
| Agriculture | 161 | 6.7 | 598 | 7.1 |
| Medicine | 454 | 18.9 | 1,571 | 18.9 |
| Military science | 8 | 0.3 | 92 | 1.1 |

**SOURCE:** *Academic Degrees and Graduate Education,* 72 (1): 50, 1997.

## Future Trends in Graduate Expansion: 1995-2020

Graduate enrollment is affected primarily by the growth rate of both the national economy and the relevant age cohort. In China, to a great extent, it is also affected by public policy determinations to either set enrollment quotas to restrict growth or to let enrollment be driven by demand. The projection here is mainly based on the first two factors: the growth rate of the economy and the relevant age group.

The demand for high-level educated personnel depends to a large extent on how fast the economy grows. According to the newly issued long-term development target for the year 2010, the Chinese government's target for gross domestic produce (GDP) in 2000 is to quadruple that of 1980, and for GDP in 2010 to double that of 2000. This requires an average annual growth rate of 8 percent between 1995 and 2000, and of over 7 percent between 2000 and 2010.

Given the momentum of China's economic growth rate in the period between 1978 and 1994, it is realistic to expect GDP to continue to grow at an average annual rate of 7 to 9 percent in real terms over the next 25 years.

**Table 3. Percent distribution of master's and doctoral degrees awarded by field of study (1981-95)**

| Number and Percent | Total | Philosophy | Economics | Law | Education | Literature | History | Sciences | Engineering | Agriculture | Medicine | Military science |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Master's degree | 313,006 | 5,681 | 17,731 | 11,701 | 5,166 | 15,914 | 6,669 | 60,527 | 141,119 | 13,115 | 34,690 | 693 |
| Percent | 100.0 | 1.8 | 5.6 | 3.7 | 1.7 | 5.1 | 2.1 | 19.3 | 45.1 | 4.2 | 11.1 | 0.2 |
| 1981 | 8,665 | 178 | 163 | 56 | 21 | 530 | 209 | 2,387 | 3,949 | 198 | 974 | 0 |
| 1985 | 12,618 | 207 | 575 | 336 | 158 | 648 | 390 | 3,204 | 5,188 | 834 | 1,708 | 0 |
| Percent | 100.0 | 1.6 | 4.6 | 2.7 | 1.3 | 5.1 | 3.1 | 25.4 | 41.1 | 6.6 | 8.5 | 0.0 |
| 1986 | 14,938 | 260 | 654 | 607 | 133 | 611 | 316 | 3,104 | 6,609 | 798 | 1,846 | 0 |
| 1990 | 32,557 | 686 | 1,850 | 1,165 | 585 | 1,374 | 793 | 6,157 | 14,396 | 1,406 | 4,093 | 52 |
| Percent | 100.0 | 2.1 | 5.7 | 3.6 | 1.8 | 4.2 | 2.4 | 18.9 | 44.2 | 4.3 | 12.6 | 0.2 |
| 1994 | 26,166 | 418 | 2,024 | 1,321 | 517 | 1,477 | 437 | 4,592 | 11,672 | 884 | 2,689 | 135 |
| 1995 | 28,098 | 384 | 2,207 | 1,390 | 547 | 1,484 | 499 | 4,653 | 13,174 | 903 | 2,723 | 134 |
| Percent | 100.0 | 1.4 | 7.8 | 5.0 | 2.0 | 5.3 | 1.8 | 16.6 | 46.9 | 3.2 | 9.7 | 0.5 |
| Doctorate degree | 22,162 | 345 | 891 | 428 | 211 | 523 | 503 | 6,192 | 8,725 | 773 | 3,560 | 0 |
| Percent | 100.0 | 1.6 | 4.0 | 1.9 | 1.0 | 2.4 | 2.3 | 27.9 | 39.4 | 3.5 | 16.1 | 0.0 |
| 1981 | 13 | 0 | 0 | 0 | 0 | 0 | 0 | 12 | 1 | 0 | 0 | 0 |
| 1985 | 234 | 5 | 0 | 0 | 0 | 6 | 10 | 94 | 87 | 0 | 32 | 0 |
| Percent | 100.0 | 2.1 | 0.0 | 0.0 | 0.0 | 2.6 | 4.3 | 40.2 | 37.2 | 0.0 | 13.6 | 0.0 |
| 1986 | 307 | 7 | 3 | 1 | 1 | 10 | 7 | 119 | 122 | 2 | 35 | 0 |
| 1990 | 2,127 | 29 | 137 | 34 | 16 | 45 | 36 | 590 | 828 | 88 | 324 | 0 |
| Percent | 100.0 | 1.4 | 6.4 | 1.6 | 0.8 | 2.1 | 1.7 | 27.7 | 38.9 | 4.1 | 15.2 | 0.0 |
| 1994 | 3,590 | 53 | 170 | 98 | 43 | 92 | 68 | 918 | 1,389 | 125 | 634 | 0 |
| 1995 | 4,364 | 60 | 198 | 102 | 52 | 116 | 76 | 1,191 | 1,659 | 182 | 728 | 0 |
| Percent | 100.0 | 1.4 | 4.5 | 2.3 | 1.2 | 2.7 | 1.7 | 27.3 | 38.0 | 4.2 | 16.7 | 0.0 |

**SOURCE:** *Academic Degrees and Graduate Education,* 72 (1): 51, 1997. *Academic Degrees and Graduate Education,* 71 (6): 73, 1997.

Table 4 provides estimates per capita GDP based on three scenarios of average annual GDP growth rate: (1) slow growth at 7 percent, (2) medium growth at 8 percent, and (3) fast growth at 9 percent. According to these projections, China's per capita GDP would be US$600 to US$700 by 2000, US$1,100 to US$1,600 by 2010, and US$2,100 to US$3,500 by 2020.[5]

**Table 4. Expansion trends of graduate education, 1994-2020 (in constant 1994 yuan)**

| Rate of Growth | 1994 | 2000 | 2010 | 2020 |
|---|---|---|---|---|
| | **GDP per capita in yuan** | | | |
| Slow growth (r=7%)......................... | 3,800 | 5,400 | 9,900 | 18,300 |
| Medium growth (r=8%).................... | 3,800 | 5,700 | 11,500 | 23,300 |
| Fast growth (r=9%)......................... | 3,800 | 6,000 | 13,300 | 29,600 |
| | **In dollars (8. 5 Yuan=$1)** | | | |
| Slow growth (r=7%)......................... | 447 | 630 | 1,200 | 2,200 |
| Medium growth (r=8%).................... | 447 | 670 | 1,300 | 2,700 |
| Fast growth (r=9%)......................... | 447 | 710 | 1,600 | 3,500 |
| | **Enrollment ratio (%)** | | | |
| r=7. 6%............................................ | 0.11 | 0.15 | 0.43 | 0.81 |
| r=9. 8%............................................ | 0.11 | 0.19 | 0.64 | 1.47 |
| | **Enrollment (thousand students)** | | | |
| r=7. 6%............................................ | 128 | 186 | 387 | 805 |
| r=9. 8%............................................ | 128 | 224 | 571 | 1,455 |
| Country income level....................... | Low | Becoming lower-middle | Lower-middle | Becoming upper-middle |

**NOTE:** The numbers are rounded.

**SOURCE:** The World Bank Report No.15573-CHA, pp. 61-62 and pp. 148-151. China Statistical Yearbook 1995, China Statistical Publishing House, 1995, p 62.

The population for graduate education in China is here referred to as the 25- to 29-year-old age cohort. The reason for choosing this age group is mainly that the average age of all recipients of master's degrees awarded between 1991 and 1994 is 27.5 years (table 5). Given the current system of Chinese graduate education, the time span for master's degree studies is between 2.5 and 3 years. That means that when they entered graduate school, students were around 25 years old. Though the average age of doctoral degree recipients for this period is 31, the real average time span for doctoral studies in China is about 3.5 years (ADC and SEdC 1995), which means these students entered doctoral programs at the age of 27.5.

The population of 25- to 29-year-olds in China is projected by the World Bank to decline gradually from 1994 to around 2005, when the generation born after the implementation of China's 1979 one-child policy comes of age. The size of the 25- to 29-year-old age cohort is projected to fluctuate between 90 million at the lowest point in 2010 and 115 million at the highest in 2015, and then to go down to 99 million in 2020.

**Table 5. Average age of doctoral and master's degrees awarded through full-time studies, 1991-94 (number of persons)**

| Year | Doctoral degree | | Master's degree | |
|---|---|---|---|---|
| | Total | Average age | Total | Average age |
| 1991......... | 2,519 | 31 | 29,112 | 27 |
| 1992......... | 2,503 | 31 | 23,572 | 27 |
| 1993......... | 2,082 | 31 | 23,029 | 28 |
| 1994......... | 3,523 | 32 | 24,780 | 28 |

**SOURCE:** *Data of Academic Degrees and Graduate Education Statistics to 1991-1994,* China Archives Press, 1995.

Projected graduate enrollment is based on two different enrollment growth rates (table 4):

- **Gradual Growth.** If graduate enrollment follows the historical average annual undergraduate enrollment growth rate of 7.6 percent up to 2020, China would reach an enrollment ratio of 0.15 percent of the 25- to 29-year-old age cohort by 2000, 0.43 percent by 2010, and 0.81 percent by 2020. This growth rate lags behind historical GDP growth rates, but keeps pace with undergraduate enrollment—if the latter maintains its established

[5]The World Bank's definition of country income level is as follows: low-income countries are those with a per capita GNP of US$695 or less, lower middle-income countries are those with a per capita GNP between US$696 and US$2,784, and upper middle-income countries are those with a per capita GNP between US$2,784 and US$8,626 (World Bank 1995).

growth rate over the next 25 years. If both undergraduate and graduate enrollments grow at the same rate of 7.6 percent in the next 25 years, the ratio between them will be at the 1994 level: 100:4.57.

- **Fast Growth.** If graduate enrollment growth is to catch up with the historical average annual GDP growth rate of 9.8 percent, the enrollment ratio would reach 0.19 percent by 2000, 0.64 percent in 2010, and 1.47 percent in 2020. Although total enrollment by 2020 would be 1,455,000, the enrollment ratio would still only be 1.47. However, this enrollment could be considered enormous because, if 25 to 30 percent of the students graduate annually (the majority of graduate students in China study full time, so it is entirely possible for them to complete their studies within the prescribed 3-year time span), the number of graduate degrees awarded would be about 400,000. This is similar in scale to the United States—which has the largest graduate system in the world—where advanced degrees awarded annually number about 300,000 master's degrees; 35,000 Ph.D. degrees; and 70,000 first professional degrees (e.g., M.D., Ed.D., J.D., etc.).

Beyond the two principal factors discussed above—growth rate of the national economy and population of the relevant age cohort—are two other considerations.

### Projection of GDP

To estimate the public resources available in the future, three scenarios are projected of average annual GDP growth rates between 1995 and 2020 at 7 percent, 8 percent, and 9 percent. The reason for choosing these average annual growth rates is that 7 and 8 percent fall within the Chinese government's own target, and 9 percent is close to the historical growth rate of 9.8 percent between 1978-94. Projected GDP forms the basis for projection of the Chinese government's expenditure on higher education.

### Projection of Government Expenditure on Higher Education

The projection of government expenditure on higher education assumes that future government expenditure remains at 12.9 percent of GDP (the ratio in 1994), and that the government expenditure on higher education is about 2.6 percent of total government spending (the ratio of 1992). The reason for choosing the 1992 ratio instead of the 1994 ratio is that the government expenditure on higher education in 1994 increased considerably over previous years; this level might conflict with the overall objective of deficit reduction. The projection is based on a pessimistic assumption that the future growth of revenue remains unchanged and that the future growth of public spending on higher education will be constrained by the need to reduce the consolidated government deficit. Using these ratios for projection, total government expenditure on higher education would increase from about Y19 to 79 billion (in constant 1994 rates), if the GDP grows at 7 percent per year between 1994 and 2020; it would grow to Y100 billion if the GDP grows at 8 percent, and to Y128 billion if the GDP grows at 9 percent (World Bank 1996).

## Overseas Study and International Mobility of Scientists and Engineers

### Overseas Study

The Chinese government's decision to send thousands of students for overseas study represents a historical continuity rather than a radical departure in modern China's cultural policy. For over a century, with the sole exception of the period from 1967-74, Chinese students have been studying abroad, frequently in large numbers. The roles played by the generations of returned Chinese students educated abroad in social, economic, scientific, and political modernization in general, and educational modernization in particular, have been important historically. In fact, the modern higher education system in China is a direct result of China's contact with the outside world, both West and East, brought back by returned foreign-trained students. In contrast to earlier periods, today's overseas student situation has three striking features.

First is its vast scale and scope. During the period 1978-98, about 300,000 students—50 times as much as the figure (11,900) for the 28-year period 1950-77—went to more than 100 countries and areas for overseas study; the United States was the major host country (*China Spectrum* 1998). More than half of these students were enrolled in American universities. Table 6 clearly shows the dramatically increasing enrollment and ratio of Chinese students among total foreign students in American universities from 1980-96: enrollment increased 14.3 times from 2,770 to 39,613, while the proportion rose from 0.9 percent to 8.7 percent. In comparison, the total number of foreign students in the United States increased from 311,880 to 453,787, or only 45.5 percent, in the same period. Therefore, students from China became by far the fastest growing community on American campuses. Although Chinese students have, during recent years, been the second largest foreign student population after Japanese students, during the period 1989-94, they took the lead in total foreign student enrollment in the United States. The relative decline of Chinese student enrollment after 1994 was affected by the situation in China, where the second reform tide after 1992 led to more opportunities in both the job market and graduate studies at home. As a result, the wave of overseas students slowed to some extent in recent years.

**Table 6. Foreign students enrolled in American universities, 1980-81 to 1995-96**

| | Total foreign students | Country of origin: China | Country of origin: Japan |
|---|---|---|---|
| | 1980-81 | | |
| Number | 311,880 | 2,770 | 13,500 |
| Percent | 100.0 | 0.9 | 4.3 |
| | 1985-86 | | |
| Number | 343,780 | 13,980 | 13,360 |
| Percent | 100.0 | 4.1 | 3.9 |
| | 1989-90 | | |
| Number | 386,850 | 33,390 | 29,840 |
| Percent | 100.0 | 8.6 | 7.7 |
| | 1990-91 | | |
| Number | 407,530 | 39,600 | 36,610 |
| Percent | 100.0 | 9.7 | 9.0 |
| | 1991-92 | | |
| Number | 419,590 | 42,940 | 40,700 |
| Percent | 100.0 | 10.0 | 9.7 |
| | 1992-93 | | |
| Number | 438,620 | 45,130 | 42,840 |
| Percent | 100.0 | 10.0 | 9.8 |
| | 1993-94 | | |
| Number | 449,704 | 44,381 | 43,770 |
| Percent | 100.0 | 9.9 | 9.7 |
| | 1994-95 | | |
| Number | 452,635 | 39,403 | 45,276 |
| Percent | 100.0 | 8.7 | 10.0 |
| | 1995-96 | | |
| Number | 453,787 | 39,613 | 45,531 |
| Percent | 100.0 | 8.7 | 10.0 |

**SOURCE:** U.S. Department of Education, *Digest of Education Statistics 1996 and 1997,* p. 450 and p. 456.

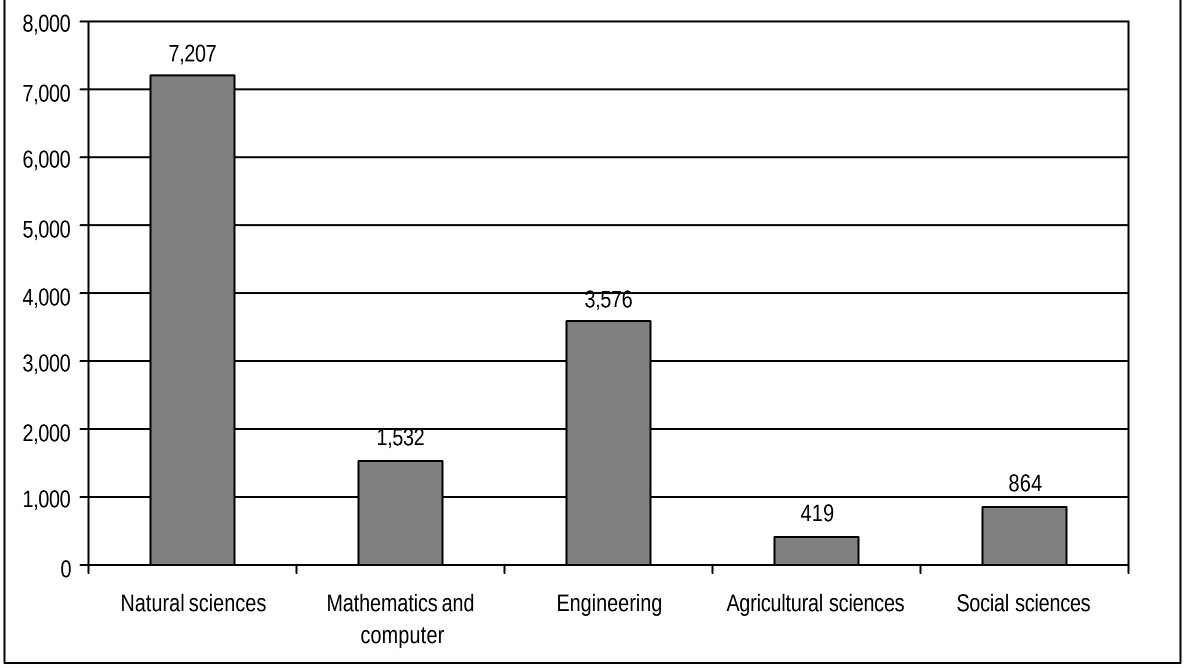
The second characteristic of the current situation is its advanced educational level. The majority of Chinese students go abroad for graduate rather than undergraduate studies. For example, among those Chinese students who were enrolled in American universities in the 1995-96 academic year, graduate students accounted for more than 80 percent (NSB 1998). Graduate training, especially at the doctoral level, is associated with research. The data in figure 2 show that, from 1988-95, American universities granted Chinese students 14,705 doctoral degrees; of these, 92.5 percent (13,598) were in science and engineering (S&E) fields. Many Chinese graduates continued their research activities as postdoctoral students after earning their Ph.D.s.

The third issue concerning overseas study is the serious problem of "brain drain": at least half of Chinese students are extending their stays or trying to seek permanent residency in foreign countries. According to incomplete statistics from the Chinese Embassy in the United States, in the past 20 years, about 160,000 Chinese students came to the United States to study; by 1998, only 30,000 of them had returned home. According to data from the U.S. National Science Foundation for the period 1990-96, the percentages of foreign S&E doctoral recipients planning to remain in the United States increased. Over 68 percent planned to locate in the United States, and nearly 44 percent had firm offers to do so. The data in table 7 show that, in 1990, 41 percent of over 1,000 Chinese S&E doctoral recipients in U.S. universities had firm plans to remain in the United States. By 1996, about 56 percent of the nearly 3,000 Chinese S&E doctoral recipients from U.S. universities had firm plans to remain in the United States. The underlying cause for this shift is the large number of Chinese students granted permanent residence status in the United States in 1992 following China's response to student demonstrations (NSB 1998).

Beyond clearly political factors, the reasons behind the rapidly growing number of nonreturning Chinese students include the relatively poor working and living conditions in China. This whole phenomenon of overseas students who do not return has severely damaged domestic teaching, research, and research and development. Given the scarcity of human resources in the country and its ambitious economic development program, such a large outflow of high-level specialized personnel represents a severe brain drain problem for China (Cao 1996).

The Chinese government has made efforts to reduce brain drain in the past 20 years. These efforts have varied over time. In general, before the mid-1980s, the

**Figure 2. Chinese S&E Ph.D. degrees recipients from U.S. universities, by major field, 1988-95**




**SOURCE:** National Science Foundation, Division of Science Resources Studies (SRS), Survey of Earned Doctorates, 1998.

**Table 7. Chinese Ph.D. recipients from U.S. universities who plan to stay in the U.S. (1990-96)**

| Year | All fields | | | | |
|---|---|---|---|---|---|
| | Total Ph.D. recipients | Plan to stay in U.S. | | Firm plans to stay in U.S. | |
| | Number | Number | Percent | Number | Percent |
| 1990.......... | 1,225 | 725 | 59.2 | 502 | 41.0 |
| 1991.......... | 1,919 | 1,523 | 79.4 | 920 | 47.9 |
| 1992.......... | 2,238 | 1,980 | 88.5 | 1,080 | 48.3 |
| 1993.......... | 2,416 | 2,134 | 88.3 | 1,077 | 44.6 |
| 1994.......... | 2,772 | 2,548 | 91.9 | 1,223 | 44.1 |
| 1995.......... | 2,979 | 2,744 | 92.1 | 1,341 | 45.0 |
| 1996.......... | 3,201 | 2,896 | 90.5 | 1,788 | 55.9 |

**SOURCE:** National Science Board, *Science and Engineering Indicators 1998,* (NSB 98-1), pp. A-89-A90, Arlington, VA, 1998.

policies on study abroad were considered “fairly liberal” by foreign experts (Altbach 1991). For example, in 1984, the State Council announced: “All Chinese citizens who are able to secure financial support in foreign currency or foreign scholarships through proper means and who have gained admission to foreign educational institutions can apply for undergraduate or graduate studies at their own expense regardless of former education, age, or length of employment” (Du 1992). After the mid-1980s, the Chinese government became conscious of the fact that over 95 percent of the students sponsored by the government did not show any sign of coming back (Zhao 1996). As a result, the state gradually limited the number of government-sponsored students and set more and more rules to restrict their numbers.

Two important rules aimed to reduce the ratio of those going abroad and those not returning. According to the first rule, a bachelor’s degree-holder had to work in China for at least 5 years, and a master’s or doctoral degree-holder for at least 2 years, before going abroad. Since the majority of Chinese students were seeking their permanent residency in the United States, the second rule was set to reduce the ratio of emigration. The Chinese government planned to send the majority of students to countries that were capable of accepting more, but that had taken few so far. Of the government-sponsored students, about 20 percent would be sent to the United States, 50 percent to Europe, 20 percent to Australia, and 10 percent to Japan (Reed 1988).[6] After the June 4 event in 1989, due to some restrictions, the number of going abroad was further reduced. However, this picture has begun to change since 1992, when more relaxed and liberal policies on overseas study were formulated.

[6]The real intention of the Chinese government was to send more students to European countries whose immigration laws are very strict.

## International Mobility of Scientists and Engineers

In 1996, the Chinese government strategy started to shift from concentrating on the return of overseas Chinese students and professionals, as well as blocking the outflow of scholars and students, to tolerating their migration, optimizing their contributions, and improving the home environment (Cao 1996). A new policy of supporting study abroad, encouraging return and free movement in and out of the country was introduced in 1992; and the government made a clear connection between supporting study abroad and the nation's strategic development in the next century. This new policy represents the most relaxed policy on study abroad in China since 1978. To some degree, this has encouraged China's high-level specialized personnel to join in the international scientific community, generating greater international mobility of scientists and engineers in and out of China. This is demonstrated in several ways, including the following.

**Reform in Overseas Study Policies.** In 1996, the State Overseas Study Foundation was established to select and sponsor qualified scholars nationwide for overseas study. Most of them are visiting scholars, and the length of stay is usually 1 year. Each candidate has to sign a contract with the foundation, along with a guarantor. If the candidate fails to return on schedule, the guarantor has to help the foundation get the candidate to return or pay fines stipulated in the contract. In 1998 alone, 1,709 scholars were selected and sponsored for overseas study. The data show that the return ratio of those sponsored by the foundation since 1996 is 85.7 percent. All those who remained have paid off the fines (*Chisa* 1998).

**New Policies on Attracting Students.** Since 1992, many educational and research institutions and organizations in China have formed career delegations that have visited the United States, Britain, Germany, Japan, and other developed countries to recruit overseas Chinese students and professionals. Since then, an increasing number of Chinese students and professionals are going back to China for either long-term work assignments or short-term academic and business visits. For example, between 1993-94, more than 10,000 overseas Chinese students and scholars made such visits. In 1994, 65 Ph.D.s returned to China from France alone.

Many institutions in China have taken measures to improve the home environment in attempts to attract overseas Chinese students and professionals. The Chinese Academy of Sciences is seeking an extra Y2 billion (US$240 million) a year for recruiting 600 bright young researchers from overseas in 1998 to 2000 (*Nature* 1998). The Ministry of Education announced in August 1998 that it would establish a special professorship system. Within the next 3 to 5 years, 300 to 500 outstanding young researchers would be selected from both home and abroad and granted the rank of specially appointed professors by key Chinese universities (*Chisa* 1998).

Many local governments in China also have established special policies to attract overseas Chinese students. In Shanghai alone, according to a recent report, 16,000 students have returned as of August 1998. In addition, several thousand overseas Chinese scholars have arranged business visits with the municipal government, and 557 have registered and opened businesses. Most of these represent high-tech companies and consulting firms (*Chisa* 1998).

With their newly acquired knowledge and expertise, these returned students and scholars have been playing key roles in China's higher education, scientific research, and production management. For example, of the 36 institutions of higher learning directly administered by the SEdC, more than half were headed by returned scholars. In many universities, over 80 percent of the academic leaders and chairpersons have some overseas experience.

**Acceptance of Foreign Students for Study in China.** From 1978-97, more than 258,000 foreign students came from over 160 countries and regions to China for study at different levels, including baccalaureate, master's, and doctoral programs as well as short-term programs. In 1997 alone, over 43,000 foreign students—35.8 times as many as the number (1,200) in 1978—were studying in China. Of the 4,569 foreign students sponsored by the Chinese government in 1997, 4.9 percent were enrolled in doctoral programs, 14.5 percent in master's degree programs, and 33 percent in bachelor's degree programs. In addition, in the same year, 39,035 were self-financed, of which 2 percent were pursuing doctoral degrees, 4.6 percent master's degrees, 28 percent bachelor's degrees, and 0.3 percent short-term diplomas (*Chisa* 1998).

In addition to the foreign students studying in China, there are also more students from overseas regions of Hong Kong, Macao, and Taiwan coming to study in mainland China. During the 10-year period 1988-97, 403 students from these three regions were enrolled in Chinese universities. Most were graduate students (*Chisa* 1998).

**International Exchange Activities.** From 1979-96, according to incomplete statistics, the cumulative number of foreign scientists and engineers invited for various types of visits by China reached 570,000. In 1997 alone, more than 80,000 foreign experts and scholars were working in China (*Chinanews* 1998). In 1996, about 7,000 Chinese teachers and experts working in various fields were sent abroad to teach or give short-term lectures. During the period 1978-97, the number of Chinese scholars going abroad to attend international conferences and the number of foreign participants coming to China to attend international conferences hosted by Chinese institutions both exceeded 11,000 (Liu 1998).

**Jointly Run Institutions.** In addition to these international exchanges, some forms of international cooperation also took shape. An example of inter-institutional collaboration is the Nanjing-Johns Hopkins Center for Chinese and American Studies. Opened in the fall of 1986, it is jointly run by Nanjing University of China and Johns Hopkins University of the United States. The center offers a two-semester graduate-level curriculum in culture, economics, politics, foreign policy, international relations and law, modern history, and U.S.-China relations. The American students make up half of the total student body; Chinese students make up the other half. The author's personal experience in meeting American graduates from this center has been that they demonstrate substantial expertise on Chinese affairs and make contributions to the promotion of mutual understanding and friendship between China and America.

As early as 1993, some top Chinese universities, such as Beijing University, Shanghai Jiaotong University, and Nanjing University, started to offer 3-year Chinese master of business administration programs for Mandarin-speaking managers; these were offered first in Singapore and then in Malaysia. Xiamen University began offering a 6-year degree correspondence course in Chinese language and literature in Singapore in 1994 in collaboration with local institutions. This is the first time Chinese universities have offered Chinese degrees to individuals outside the country (Meng 1994).

## CONCLUSION

It has been 20 years since graduate education was resumed in China in 1978. During this period, while Chinese graduate education has experienced remarkable development, many deficiencies remain in a course characterized by uneven development. Graduate education was resumed in a planned economy context and is being developed in a transition period toward a market economy. Thus, Chinese graduate education inevitably bears the dual imprints of the two periods. The current Chinese graduate education system is somewhat of a hybrid of the Soviet system and the American system, but it is tending to move toward the later. One of the main challenges faced by the Chinese government is to keep an appropriate growth rate for graduate education in accordance with future economic development and to readjust the disciplinary structure to meet the needs of a transition from an extensive-type (labor-type) economic growth to an intensive-type (knowledge-type) economic growth.

Chinese policies on overseas study have not been entirely successful. Although the situation in China has been improving, there are still many Chinese students and scholars going and remaining abroad. In recent years, China has started to participate in the international scientific community, but the scale is still limited in comparison to some other countries and regions. Of the many factors affecting the movement of overseas students and scholars, economics always plays a critical role. South Korea and Taiwan had a similar problem of brain drain before the mid-1980s. However, when their per capita GNP reached about US$4,000, their overseas students and scholars started to flow back home. Currently, China has a per capita GNP of nearly US$700. If the country continues to reform its economic structure, relying on scientific and technological progress in its transition to a market economy, the demand for specialized personnel will be high. Considering China's special circumstances, it seems likely that, when it has a per capita GNP of US$2,500 to US$3,000, China will turn brain drain to brain gain and benefit from the reverse flow of overseas Chinese students and scholars.

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# Graduate Education Reforms and International Mobility of Scientists and Engineers in Hong Kong

*Yugui Guo*

As of July 1, 1997, Hong Kong ceased to be a colony of the United Kingdom and became a special administrative region (SAR) of the People's Republic of China under a "one country-two systems" arrangement. According to this arrangement, Hong Kong has been promised self-rule; it has also been promised that its higher education system can retain its unique characteristics rather than having to align with the mainland Chinese system. This paper explores higher education issues in Hong Kong.

## General Review

Hong Kong has been a Chinese territory since ancient times, except for the period 1842-1997 when it was a British colony. Situated at the southeastern tip of China, Hong Kong has a total land mass of only 1,092 square kilometers. Though it ranks 90th in terms of population, Hong Kong is the world's 8th largest trading economy. Its 6.3 million inhabitants (97 percent Chinese) enjoy the second highest living standard in Asia.

Higher education in Hong Kong has existed for more than 80 years. The oldest current institution is the University of Hong Kong (HKU) which was founded in 1911. As the governors were not always interested in making decisions on Hong Kong education (Ip 1998), it was not until 1963 that a second university, Chinese University of Hong Kong (CUHK), was established. However, as Hong Kong industry and commerce moved from low-skilled, low-wage production toward more sophisticated markets and outputs, employers needed a better educated workforce; they also needed more people educated at the highest level. The pressure for wider access to higher education was met in part by expanding existing institutions and in part by founding new ones. At present, there are eight institutions of higher education that receive funds from the University Grants Committee (UGC):

- HKU,
- CUHK,
- City University of Hong Kong (CityU),
- Hong Kong Baptist University (HKBU),
- Lingan College (LC),
- Hong Kong Polytechnic University (PolyU),
- Hong Kong University of Science and Technology (HKUST), and
- Hong Kong Institute of Education (HKIEd).

These institutions fulfill different roles in accordance with their size, tradition, and level; this information is summarized (with some simplification) in table 1.

CityU and PolyU, until recently polytechnics, emphasize the application of knowledge and vocational training. HKBU and LC stem from a liberal arts tradition, which regards breadth of education as important. CUHK,

**Table 1. Current roles of UGC institutions**

| Institution | Sub-degree work | First degree work | Graduate degrees | Research | Professional schools | Links with industry or community |
|---|---|---|---|---|---|---|
| CityU and PolyU | substantial | substantial | some | some areas | some | strong |
| HKBU | - | predominant | some | some areas | - | strong |
| LC | - | predominant | minimal | some areas | - | strong |
| CUHK and HKU | - | substantial | substantial | all areas | many | high level |
| HKUST | - | substantial | substantial | all relevant areas | some | high level |
| HKIEd | substantial | - | - | - | - | strong |

**KEY:** (-) indicates not applicable.

**SOURCES:** University Grants Committee (UGC), *Higher Education in Hong Kong,* Hong Kong, 1996; and UGC, *Roles and Operations,* Hong Kong, 1998.

HKU, and HKUST have major professional schools and substantial research programs. CUHK and HKU are full-scale universities, and both have medical schools. HKIEd, which joined the UGC July 1, 1996, currently offers predominantly subdegree programs (similar to the U.S. associate degree) of teacher education and continuing professional education so as to serve teachers and help maintain strong links with both schools and the teaching profession.

## Levels and Qualifications of Higher Education

Hong Kong's children are required to remain in school until the age of 15 or the end of secondary 3,[1] whichever is earlier. They thus all receive a minimum of about 3 years of secondary education. After secondary 3, some children drop out of formal education, while others join craft and technician courses, but about 91 percent choose to stay at school for a further 2 years. They take curricula leading to the Hong Kong Certificate of Education Examination (HKCEE). Some of the learning opportunities after the HKCEE lie within Hong Kong's broad structure of higher education. These include 2- to 3-year subdegree courses, usually vocational in nature; and 3-year courses of teacher education.

At present, 38 percent of children remain in school after secondary 5 (HKCEE) and take 2-year sixth form courses leading to the Hong Kong Advanced Level Examination (HKALE). Students with appropriate grades in the HKALE may then enter 3-year diploma or first degree courses or 2-year courses of teacher education. To enter a full-time undergraduate program, a student must meet general educational qualifications, usually including proficiency in English and Chinese; and have passed the HKALE at least once. For science, technology, and medical programs, there are also specific HKALE or HKCEE subject requirements; similar requirements are less common in the arts and social sciences.

In general, a full-time undergraduate course lasts 3 years. Some courses are of 2 years' duration because they build on an earlier qualification such as a diploma in the same subject area. Additionally, students may be admitted to the second year of a 3-year course if they possess "advanced standing" by virtue of previous study or experience. On the other hand, some undergraduate courses are extended to 4 years because they contain one or more periods of professional experience. Examples include the courses in language education and the bachelor of science degree in speech and hearing sciences at HKU.

Those gaining first degrees or equivalent qualifications may subsequently be admitted to taught higher degrees or may undertake research for a master's degree or doctorate.[2] Full-time postgraduate courses leading to master's degrees or doctorates are restricted to the UGC institutions, but part-time provision is more widespread. Some non-UGC institutions offer part-time programs leading to postgraduate diplomas, certificates, or degrees. Postgraduate certificate and diploma courses usually take 1 year of full-time study or 1 to 2 years part time. Master's courses take 1 to 2 years full time or 2 to 3 years part time. The purposes of taught postgraduate courses are diverse. The diploma and certificate in education courses run by HKBU, CUHK, HKU, and HKIEd qualify successful participants to teach in secondary schools. The postgraduate certificate in law offered by CityU and HKU enables successful students to enter the legal profession as student barristers or solicitor trainees. Other postgraduate courses take specialist knowledge in a particular field beyond that acquired in undergraduate courses: an example is the M.A. degree in arbitration and dispute resolution offered at CityU.

Taught postgraduate courses are the principal means by which higher education institutions can respond swiftly to changing situations and the changing needs of both students and society. The various UGC institutions choose different ways to organize their taught courses and different nomenclature to describe them. For example, HKU's nine faculties offer about 60 taught postgraduate courses under specific degrees such as the master of science in urban planning or advanced diploma in orthodontics. CUHK has 35 graduate divisions which offer 15 master of arts, science, or social science courses and 2 diploma programs. HKUST has about 14 taught postgradu-

[1]In Hong Kong, compulsory education lasts for 9 years. Primary schooling begins at the age of 6 and lasts for 6 years, and secondary junior schools offer a 3-year course in a broad range of academic subjects.

[2]In both the United Kingdom and Hong Kong, postgraduate education falls into two categories. The first category is programs based mainly on systematically taught courses that characteristically lead to a master of arts or master of science degree. These programs have only coursework, with no research or thesis requirements. The second type of program leads to a master of philosophy or doctor of philosophy (Ph.D.) degree. These degrees are largely awarded on production of a thesis or dissertation through research training (Henkel and Kogan 1993, p. 72).

ate courses, including some interdisciplinary ones, under fairly general titles. CityU's four faculties have some courses with specific titles. PolyU's taught graduate courses, mostly part time and on a credit accumulation basis, are offered by individual departments: there are about 50 in all, but many are based on a modular scheme incorporating common units. HKBU has a small number of courses of recent origin. In all, there are about 170 taught postgraduate courses available, with a typical class size of 10 to 20 full-time-equivalent students.

Many of the taught master's degrees can be extended to a master's of philosophy (M.Phil.) by the incorporation or addition of a substantial piece of research and presentation of a thesis; the M.Phil. is well-regarded in Hong Kong. The additional work is usually expected to take from a few months to a year. Other M.Phil. programs stand alone or are structured as the preliminary stages of a Ph.D. degree. The Ph.D. supposedly takes 3 to 4 years full time (the UGC has recommended support for up to 4 years), or about 5 to 6 years part time. Approximately 60 percent of students pursuing an advanced research degree take the M.Phil.; 40 percent take the Ph.D.

In an endeavor to reduce the costs of preliminary training for Ph.D. research, the science faculties in the institutions have recently introduced a scheme for joint courses. In some scientific and technological areas, because of the need for specialized and expensive equipment, work for an M.Phil. or Ph.D., although original, forms part of a team effort on a particular research topic. In other areas—most usually in the arts and social sciences—the research student works alone. Until quite recently, motivation for research in many Hong Kong universities was low. These attitudes have changed very markedly in the last few years. Thus, although research students have an important role to play in the conduct of research in some disciplines, it is difficult to pursue research degrees without an existing academic staff with both the motivation and means to search for new knowledge.

## Governance and Finance

Following United Kingdom tradition, universities in Hong Kong are permitted to operate with a high degree of autonomy. Individual institutions determine their own policies for recruitment of staff and students, for the nature and length of courses, and for the balance between subject disciplines (Bray 1992).

However, the government does exercise some influence through its control of finance. The most influential body on higher education in Hong Kong is the UGC, which was founded in 1965 on the model of the UK body of the same name. Its main role is "to advise government on the funding of new institutions and the upgrading of existing ones, on major subject developments to meet community needs, on employment matters, and many other subjects relevant to tertiary education in Hong Kong" (UGC 1996, p. 9). In 1972, the committee was renamed the University and Polytechnic Grants Committee (UPGC), to reflect the inclusion of the then-titled Hong Kong Polytechnic within its purview. Following the adoption of university titles by the two polytechnics and the Hong Kong Baptist College, the committee reverted to its original title—i.e., UGC—in 1994.

UGC members are appointed by the chief executive of the SAR (before July 1, 1997, by the governor), and are all prominent in their fields. The membership comprises eminent academicians, businessmen, and administrators. No government officer sits on the committee, but its secretariat is staffed by civil servants. The nationalities of its members reflect the sources of influence from abroad. In 1998, the committee included nine local Hong Kong Chinese, four British, three American (one a professor of Hong Kong Chinese origin), and two Australian members. The remaining three members are from the Netherlands, Singapore, and mainland China (UGC 1998).

As chancellor, the chief executive of the SAR (before July 1, 1997, the governor) is the nominal head of all UGC-funded institutions. The executive head of each is its vice chancellor, who is assisted by pro-vice chancellors. The senate oversees the academic affairs of a university. Each university is subdivided into faculties and departments.

The UGC is an administrative device to ensure that institutions of higher learning can be adequately financed without misuse of large sums of money while maintaining autonomy (Mak and Postiglione 1997). The key word in the title is "grants." The UGC recommends a triennial block grant for each institution. Its funding methodology is based upon two major activities: the quantity of teaching, primarily related to number of students; and the quantity of research, largely determined by the number of academic staff. Although there is much discussion between the UGC and the institutions based upon academic and other plans and opportunities, and much discussion between the government and the UGC about available finance and community needs, once the block grant is settled, each institution has very wide latitude as to its use.

In the 1997-98 academic year, the Hong Kong government spent 1.23 percent of its gross domestic product on UGC institutions. The total amount of approved grants for these institutions was HK$13,218 million (including recurrent grants of HK$11,808 million and capital grants of HK$1,410 million), accounting for 5.4 percent of total public expenditures and 27.2 percent of total public expenditures on education (UGC 1998).

Students in UGC institutions are heavily subsidized. In 1987, the government announced plans to reduce the subsidy, but projected that by 1993-94 fees would still cover only 12 percent of the total real cost. This was revised in 1991, but the new projection is still only 18 percent by 1997-98. Moreover, the government also runs a grants and loans scheme to ensure that no one will be deprived of the opportunity for higher education because of financial difficulties (Cheng 1995). The scheme seems to achieve this objective, and the high salaries for graduates make it easy for the majority of students to repay their loans.

## Expansion and Level Structure

In the 1980s, the growing demand for a more highly qualified workforce and the loss of graduates through emigration resulted in the Hong Kong government's adoption of an ambitious tertiary education development policy. The expansion of this sector was first announced by the governor in 1988. It was revised in 1989 to set an even more ambitious pace of development, with the aim of doubling the number of first-year first-degree (FYFD) places from 7,000 in 1990 to 15,000 in 1995. By then, 6 out of 10 sixth form completers would be able to participate in some form of higher education in Hong Kong. This would be 18 percent of the age group, compared with around 8 percent in 1990 (Sensicle 1992).

The expansion of FYFD places and the consequent growth in total undergraduate numbers are shown in table 2. From 1991-92 to 1997-98, FYFD places increased by 37.2 percent—from 10,665 to 14,632—and undergraduate enrollment rose by 56.9 percent—from 29,199 to 45,823. Due partly to the undergraduate expansion, postgraduate enrollment witnessed a corresponding expansion (table 2 and figure 1). During the same period, total postgraduate enrollment more than doubled, rising from 4,279 to 9,010. Of this, taught postgraduate enrollment increased by 86.4 percent—from 2,931 to 5,465—and research postgraduate enrollment rose by 163 percent—from 1,348 to 3,545.

If the government had very clear views on desirable undergraduate numbers, the issues were more complex and sometimes conflicting regarding postgraduate development. Hong Kong has been, in fact, remarkably reluctant to become involved in research. Until quite recently, there had only been a limited "research culture" in Hong Kong's higher education institutions (in 1994-95, only 50 percent of the academic staff themselves held doctorates). Partly because the recent major expansion of the system has led to the recruitment of many new staff members from outside Hong Kong, and partly due to the government's financial encouragement—including the 1991 establishment of the Research Grants Council as a support mechanism—that situation is changing. Research activity has recently grown very markedly and so has the number of postgraduate students. Table 3 shows this expansion: from 1991-92 to 1997-98, postgraduate

**Table 2. Student enrollment of UCG-funded programs, 1991-92 to 1997-98**

| Number of full-time equivalent students enrolled [a] | 1991-92 | 1992-93 | 1993-94 | 1994-95 | 1995-96 | 1996-97 | 1997-98 [b] |
|---|---|---|---|---|---|---|---|
| Total | 47,480 | 51,190 | 54,574 | 57,935 | 62,014 | 69,022 | 69,723 |
| Subdegree | 14,001 | 12,332 | 10,214 | 9,370 | 9,436 | 14,540 | 14,890 |
| Undergraduate | 29,199 | 33,351 | 38,150 | 41,782 | 44,701 | 45,965 | 45,823 |
| Taught postgraduate | 2,931 | 3,565 | 3,904 | 4,236 | 4,924 | 5,163 | 5,465 |
| Research postgraduate [c] | 1,348 | 1,943 | 2,306 | 2,547 | 2,953 | 3,353 | 3,545 |
| First-year first-degree places | 10,665 | 12,090 | 12,726 | 14,253 | 15,070 | 14,779 | 14,632 |

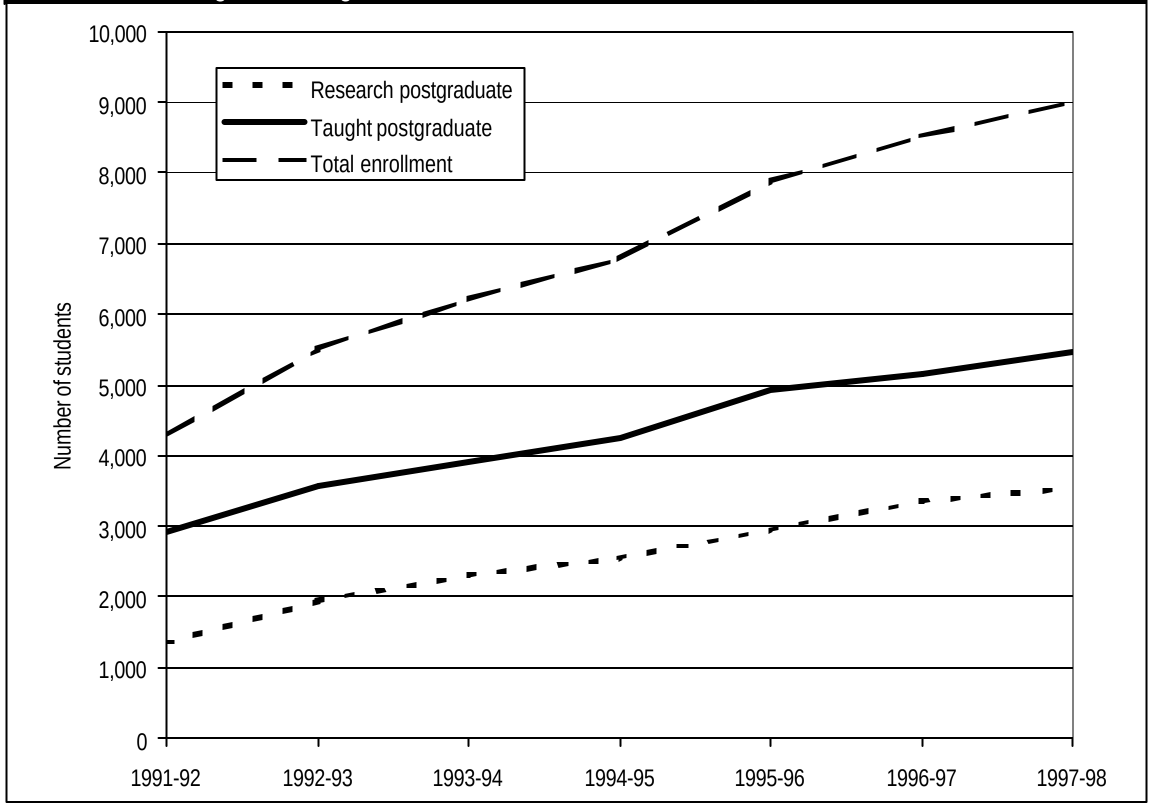
[a] Enrollment figures include blister students and nonlocal students.

[b] The Hong Kong Institute of Education came under the aegis of the UGC as of July 1, 1996.

[c] Research postgraduate figures refer to student enrollment numbers counted within UGC target.

**SOURCE:** University Grants Committee (UGC), *Higher Education in Hong Kong,* Hong Kong, 1998.

Figure 1. Postgraduate enrollment in UGC institutions, 1991-92 to 1997-98




**SOURCE:** University Grants Committee (UGC), *Higher Education in Hong Kong,* Hong Kong, 1998.

education output increased by 139.6 percent (graduates of taught postgraduates and research postgraduates increased by 98 percent and 485.5 percent, respectively).

## Distribution of Enrollment by Broad Field

The expansion of the UGC component of the higher education system did not occur uniformly across disciplines. Rather, it has largely reflected economic development and the shift of the industrial structure in Hong Kong. As the economy shifted from relying on entrepot trade in the 1950s to manufacturing in the 1960s and 1970s, skilled and semiskilled labor of more diverse sorts were in demand. With competition from neighboring newly industrialized countries, Hong Kong had to shift from labor-intensive to technology-intensive industries; this in turn meant that Hong Kong would have to function as a service center rather than a manufacturing center and that its manpower needs would be changing accordingly.

In 1993, Hong Kong had a workforce of 2.8 million. Of this, 28 percent were engaged in wholesale, retail, import and export trades, and restaurants and hotels; 11.2 percent in transport, storage, and communications services; 9.4 percent in financing, insurance, real estate, and business services; 20.2 percent in community, social, and personal services; and 21.1 percent in manufacturing. The Hong Kong Statistics Department reported that the share of the labor force employed by the manufacturing sector had declined from 47 percent in 1971 to 41.2 percent in

Table 3. Graduates of postgraduate education in UGC institutions, 1991-92 to 1997-98

| Level | 1991-92 | 1992-93 | 1993-94 | 1994-95 | 1995-96 | 1996-97[a] | 1997-98[b] |
|---|---|---|---|---|---|---|---|
| Total | 2,372 | 2,599 | 3,183 | 3,519 | 4,109 | 4,568 | 5,684 |
| Taught postgraduate | 2,117 | 2,274 | 2,668 | 2,924 | 3,386 | 3,694 | 4,191 |
| Research postgraduate | 255 | 325 | 515 | 595 | 723 | 874 | 1,493 |

[a] The Hong Kong Institute of Education (HKIEd) came under the aegis of the University Grants Committee (UGC) as of July 1, 1996.

[b] Graduate numbers for the academic year 1997-98 are projected.

**SOURCE:** University Grants Committee (UGC), *Higher Education in Hong Kong,* Hong Kong, 1998.

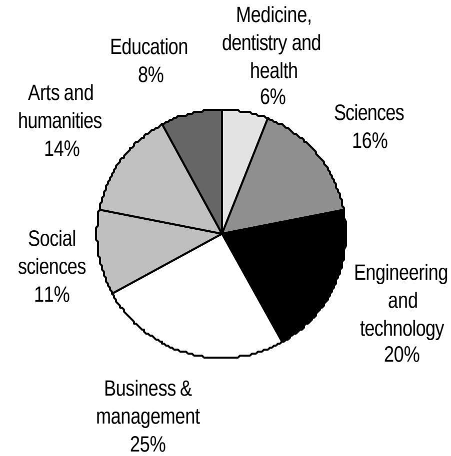
1981 and 28.2 percent in 1991 (Cheng 1995). It is obvious that education has become an increasingly important asset for a labor force that seeks to improve its remuneration and opportunities in the expanding service industries.

Table 4 demonstrates corresponding trends in disciplinary development. From 1993-94 to 1997-98, enrollment in engineering and the sciences declined from 26 percent to 20 percent and from 19 percent to 16 percent, respectively; enrollment in business and education increased from 22 to 25 percent and from 4 to 8 percent, respectively; enrollment in medicine and the social sciences remain essentially stagnant.

The largest field in higher education in 1997-98 was business studies, which accounted for a quarter of all tertiary enrollment in Hong Kong (figure 2). Engineering and the sciences are also important (accounting for 20 percent and 16 percent, respectively); with the arts and humanities marginally behind (14 percent). The social sciences and education follow (11 percent and 8 percent); together with medicine (6 percent), these occupy smaller, but important, niches.

As far as the disciplinary structure of postgraduate enrollment is concerned, the UGC report of 1996 provides a slightly different picture. Business studies (particularly toward an MBA) and education accounted for about a quarter each of taught postgraduate students. The next largest disciplines were engineering and the social sciences, a few taught postgraduates were in the sciences or humanities. Two-thirds of research students were in scientific or technological areas.

**Figure 2. Distribution of enrollment by broad disciplines in UGC institutions, 1997-98**




**SOURCE:** University Grants Committee (UGC), *Higher Education in Hong Kong,* Hong Kong, 1998.

In 1994-95, funding for new research projects through the Research Grants Council (RGC) was HK$245.6 million, as compared with HK$217.7 million through the UGC. Of RGC grants, 32 percent were awarded in engineering; 26 percent in biological science and medicine; 19 percent in physical science; and 23 percent in social science, business studies, and the humanities. The disciplinary structure of higher and graduate education to a great extent matches the current economic structure in Hong Kong, in its dual role as a leading metropolis and business hub of South China and as a regional and international financial and service center.

**Table 4. Student enrollment by broad disciplines, 1993-94 to 1997-98**

| Discipline | 1993-94 | 1994-95 | 1995-96 | 1996-97 [a] | 1997-98 [b] |
|---|---|---|---|---|---|
| Headcount (total enrollment)............. | 70,241 | 72,154 | 75,557 | 85,550 | 86,202 |
| | Percentages | | | | |
| Medicine, dentistry and health....... | 6 | 6 | 6 | 6 | 6 |
| Sciences........................................ | 19 | 20 | 18 | 16 | 16 |
| Engineering and technology.......... | 26 | 24 | 22 | 20 | 20 |
| Business and management........... | 22 | 22 | 27 | 25 | 25 |
| Social sciences............................. | 12 | 11 | 12 | 11 | 11 |
| Arts and humanities...................... | 11 | 12 | 11 | 14 | 14 |
| Education...................................... | 4 | 5 | 4 | 8 | 8 |

[a] The Hong Kong Institute of Education (HKIEd) came under the aegis of the University Grants Committee (UGC) as of July 1, 1996.

[b] Graduate numbers for the academic year 1997-98 are projected.

**SOURCE:** University Grants Committee (UGC), *Higher Education in Hong Kong,* Hong Kong, 1998.

# Overseas Study and International Mobility of Scientists and Engineers

## Overseas Study

In 1992, owing to long-standing restrictions on higher education in Hong Kong, large numbers of students went overseas, generally for three major reasons: limited educational opportunities in tertiary education, job discrimination against graduates of local institutions, and political uncertainty. Since World War II, there have been three waves of student migration. The first wave was from the late 1940s to the late 1960s; this saw students leave primarily because of discrimination at home. In general, students from mainland China universities, Hong Kong private colleges, and even from CUHK did not have equal opportunity in the job market in Hong Kong as compared to graduates from HKU. Thus they went "overseas for further studies in order to obtain qualifications recognized within the British Commonwealth or to seek opportunities elsewhere" (Wu 1992, pp. 47-48).

The second wave was caused by the student and nationalist movements of the 1960s, which culminated in the riots of 1967, and by the growth of wealth within the territory. The main push to leave Hong Kong during this phase came from both increasing affluence and political uncertainty caused by the events within China. The students who left were primarily from relatively wealthy families. Unlike their predecessors who left to pursue graduate studies, most of these second-wave students were in pursuit of undergraduate studies.

In the third wave, stimulated by political uncertainty due to the impending transfer of sovereignty to China in 1997, overseas education combined with the migration of entire families to create a major outflow of population to North America, Britain, and Australia. The majority went for university studies, but many went for secondary education as well.

Because the Hong Kong government guarded against rapid expansion of higher education before the 1980s, the supply of university places was very limited. In the mid-1970s, the proportion of those in the 17- to 20-year-old age group who had access to FYFD places never exceeded 2.5 percent (Mak and Postiglione 1997). Although the higher education sector expanded dramatically later, competition to enter higher education remained intense throughout the 1980s. In the middle of the decade, less than 3 percent of the age group in Hong Kong was able to study in local universities, a figure that compared unfavorably with 5 percent in Singapore and 10 percent in the United Kingdom (Bray 1992). As late as 1994, only three institutions in Hong Kong enjoyed university status. Because of the intense competition, many people were forced to study abroad; in the mid-1980s, Hong Kong had as many students abroad as at home. Table 5 shows that the number of students leaving in the peak year of 1990 amounted to more than half of the 41,301 students in UGC-funded institutions in 1990-91. Their intake of first-year students in the same year was 8,575. Unfortunately, just as universities in Hong Kong had achieved a respectable international standard, middle-class parents were sending their children abroad because they wanted to provide them the option of remaining overseas in preparation for 1997 (Cheng 1995).

In 1994-95, 56,000 undergraduate students were enrolled in Hong Kong universities, and 28,000 were in overseas universities, resulting in a ratio of 1:0.5. At the postgraduate level, the numbers were, respectively, 7,000 and 12,000, for a ratio of 1:1.7. Of the estimated 40,000 Hong Kong students in higher education who were studying outside the territory, about 70 percent were undergraduates. Almost all of these took full-time courses.

There are only limited data available regarding subject breakdown for these students. In the United States, 35 percent took business studies and 16 percent engineering. In the United Kingdom, the proportions were, respectively, 35 and 13 percent. In Australia, half of all Hong Kong students were taking business studies, and only 9 percent were in engineering (UGC 1996).

The relative popularity of the host countries has changed somewhat (see table 5). Traditionally, the United Kingdom received the most students from Hong Kong. In recent years, the United States has taken over. For example, in 1994-95, the United States had about 13,000 Hong Kong students in higher education;[3] the United Kingdom, 10,000; Australia, 9,000; and Canada, about 6,500. Numbers for other places of study, such as mainland China and Taiwan, were smaller, but may amount to another 2,000 in all (UGC 1996). Extensive overseas study is a drain on the economy, but helps make Hong Kong an international society.

[3]Between 1986 and 1995, American universities awarded 952 doctoral degrees to Hong Kong students (NSB 1998, p. 2-31).

| Table 5. Number of Hong Kong students leaving for overseas study, 1988-91 | | | | | |
|---|---|---|---|---|---|
| Year | United States | Canada | United Kingdom | Australia | Total |
| Total.......... | 20,776 | 19,126 | 17,172 | 16,673 | 73,747 |
| 1988...... | 4,215 | 3,808 | 3,856 | 3,147 | 15,026 |
| 1989...... | 4,855 | 5,096 | 4,539 | 4,678 | 19,168 |
| 1990...... | 5,840 | 5,681 | 4,349 | 5,258 | 21,128 |
| 1991...... | 5,866 | 4,541 | 4,428 | 3,590 | 18,425 |

**SOURCE:** Cheng, Joseph Y.S. Higher Education in Hong Kong-The Approach to 1997 and the China Factor. *Higher Education* 30(3): 257-71, 1995.

In addition to studying abroad, students have increasingly had the opportunity of gaining access to higher education through courses offered by overseas institutions of higher education in Hong Kong. The territory has always imported some education in response to demand for subjects related to service industries such as hotel management, business administration, accounting, international trade, and financial management. As recently as 1993, it was estimated that the demand for these and similar courses largely exceeded local supply; government projections forecast a continuing shortfall in 2001 (Chan and Drover 1997). Overseas institutions are beginning to compete with local institutions for students in an expanding array of courses to help meet this need. This new trend toward the globalization of educational institutions may well make this the hub of its educational exchange with the rest of the world. The influx of overseas institutions may reflect a trend of educational institutions going in search of international students instead of international students coming to them.

## International Mobility

The rapid increase in the development of higher education in Hong Kong made the government realize that continued reliance on an overseas organization was no longer appropriate and that it would be desirable to consider the establishment of a Hong Kong system. Large numbers of students were still going abroad, but this tendency was likely to become less pronounced when more local opportunities became available in the 1990s. After 1994, the number of students at local universities surpassed that going overseas (Postiglione 1998). There has been a reverse movement in recent years. Consulates-general of Western countries in Hong Kong have reported a decline in the numbers of emigration visas granted. For example, the U.S. consulate-general indicated that only 13,142 people were granted emigration visas in 1993, down from 14,882 in 1992 and 18,880 in 1991. There are also signs that an increasing number of people who had emigrated are returning to Hong Kong. The Hong Kong government estimated in 1995 that at least 12 percent of the people who had emigrated in the 10 years prior to 1992 had returned to Hong Kong (Cheng 1995).

Besides bringing its own students back home, Hong Kong is beginning to compete with established universities abroad in attracting overseas students. The numbers are at present small, but they are growing, particularly at the postgraduate level. Chan and Drover (1997) identified three reasons for moving in that direction. First is the extent that newly created wealth has enabled Hong Kong to develop university quality equivalent to other developed economies of the world. Second, this policy recognizes the value of diversifying the Hong Kong student body and welcoming students from other cultures to enhance the intellectual and research environment for students who cannot study abroad. Third, faced with potential "brain drain" in the form of increased competition from recognized universities and newly emerging private universities, all of which are using increasingly sophisticated marketing strategies to attract a rapidly expanding cohort of university aspirants whose families are able to fund their education, the best defense is for Hong Kong to take the offense by internationalizing its own student body.

The international character of Hong Kong's universities is underscored by the composition of its academic staff. In the past, chiefly because of shortages of qualified local applicants, Hong Kong institutions of higher learning employed a significant number of expatriates. The percentage has been reduced, but it remains prominent. This international influence in higher education continues, as shown in the country of origin of faculty. For example, in 1993-94, 33 percent of all faculty in nine tertiary institutions were registered as nonlocals. Comparable figures by institution show different degrees of internationalization (Mak and Postiglione 1997):

- HKUST—55 percent,
- HKU—51 percent,
- the Academy of Performing Arts—51 percent,
- CUHK—37 percent,
- LC—30 percent,
- CityU—28 percent,

- HKBU—22 percent,
- Open Learning Institute—22 percent, and
- PolyU—18 percent.

Despite the transfer of sovereignty, the academic profession in Hong Kong has maintained its staff, including a high proportion of international faculty. In fact, the 1997 transfer actually attracted many top-notch academics to Hong Kong, some of whom stayed longer than planned.

The meaning of "international" has changed somewhat. While it still refers mostly to expatriates from English-speaking countries like Britain, the United States, and Australia, an increase has been registered among Chinese from the People's Republic of China, Chinese from Taiwan, and Chinese already living in Hong Kong who hold valid passports to the latter two areas. Due to the large number of overseas appointees, the academic qualifications of faculty have been rising: about 90 percent of all doctorates of Hong Kong faculty were earned overseas, usually in Australia, Canada, the United Kingdom, or the United States (Postiglione 1997 and 1998).

# Future Trends and Concluding Remarks

Since Hong Kong became an SAR on July 1, 1997, "Hong Kong's universities have not been greatly affected" (Postiglione 1998); Ip (1998) notes that "Hong Kong seems to be the same as before." Despite this seemingly stagnant picture, Hong Kong is, in fact, changing—and change in education may serve as the best illustration.

## Enhancing Internationalization

There is a much greater sense of commitment on the part of the new government to education as compared to the old colonial regime. In his first policy address made in October 1997, the new chief executive, Tung Chee-hwa, made education a high priority and promised to make a real change in education. Two major policy initiatives on tertiary education are key in making Hong Kong's universities stronger. First, from 1998 to 2001, the new Hong Kong government will invest heavily in higher education so as to enable Hong Kong universities to achieve and maintain recognition as world-class researchers in the international academic community, keep pace with rising standards, and serve the future economic and social needs of Hong Kong. During the same period, the number of nonlocal undergraduates and taught postgraduates will be doubled from 2 to 4 percent, and the ratio of nonlocal research postgraduate students in tertiary institutions will be increased substantially from one-fifth to one-third.

## Raising Research Status

Until recently, the primary function of tertiary institutions in Hong Kong was teaching. Research, at least from the government's point of view, was not an important consideration. Government financial support for tertiary institutions was calculated on the basis of the costs involved in producing a graduate. As a result, Hong Kong's research in science and technology has not kept pace with that of its regional rivals in Singapore, Taiwan, and South Korea.

This situation has changed in the past few years. The government has come to realize that support for research would be an important factor in attracting qualified academics and research postgraduate students and in making Hong Kong more competitive in the world market. The change in attitude toward research has led to the establishment of the Research Grants Council in the early 1990s, whose principal responsibility is to support individual research projects in UGC institutions. The RGC has introduced a funding model in which part of an institution's block grant depends upon the quantity and quality of research conducted there. In addition to distributing individual research grants, the RGC has been responsible for the competitive allocation of research student numbers, again in conjunction with base numbers provided by the UGC. The general impression of the RGC, from both local and international perspectives, is that there is a flourishing and growing research culture in Hong Kong.

## Strengthening Connections With Mainland China

With the opening up of mainland China since the end of the 1970s, academic exchanges with mainland China had been developing rapidly. Scholars from mainland China see Hong Kong as a most useful and convenient window on the outside world; local academics value exchanges with China to facilitate their research. The Hong Kong government has gradually come to appreciate the significance of such exchanges, and the UGC has been offering funding for them since 1988. The UGC's allocation for academic exchanges with mainland China jumped from HK$2.5 million in 1991-92 to HK$4.4 million in 1995-96 (Postiglione 1997).

Since Hong Kong was handed over to China, its academics are not only playing a bridging role between academics from mainland China and the rest of the world, but also extending their exchanges into many other aspects. Of these exchanges, the trend toward increased movement of students and professionals is of special significance. This role includes increasing the number of both undergraduate and postgraduate students from mainland China, recruiting more academics from mainland China who earned their doctorates at home—as well as those mainlanders who, with doctorates from the United States and other Western countries, have not returned to China—and, in the long term, supplying postgraduate labor to mainland China. However, there might be educational traffic in the reverse direction. The Hong Kong government decided in 1994 to recognize for the first time the right of university graduates from both mainland China and Taiwan to apply as civil servants; one consequence of this decision is that, in the future, increasing numbers of Hong Kong students (particularly those interested in working in government) will be going to mainland China rather than to the United Kingdom or other countries for courses in higher education. It is believed that a two-way educational traffic will be of benefit to both sides, and that the integration of Hong Kong's academics into the global community will be strengthened rather than hindered by their increased engagement with academics in mainland China.

## Turning to the American Model

It is clear that the character of the academic profession in Hong Kong is changing in other ways as well. More doctorates are now earned in the United States than in the United Kingdom or other countries. Table 6 shows that, in addition to the large portion of U.S.-educated professors in the major universities of Hong Kong, former U.S. faculty are the deans and heads of almost all science and engineering departments and make up a large majority of the directors of HKUST research institutes.

It is of interest to note that those with higher degrees from the United States rate their training significantly higher than do those who earned higher degrees in the United Kingdom. The same holds true for the perception of faculty about the quality of training they received for research (Mak and Postiglione 1997). Rather than following the changing patterns in British higher education, Hong Kong has begun to draw more on innovations from the United States. Besides strengthening the research role of universities, other changes adopted include the introduction of a credit unit system; moving from the British 3-year model to the American 4-year model; and converting the title system from the British (lecturer, senior lecturer, reader, professor) to the American (assistant professor, associate professor, full professor) model. It is possible that the application of the American model will help Hong Kong universities continue their integration into the global community as well as improve the quality of education and standards of research.

**Table 6. Leading scientists and engineers in Hong Kong's major universities by country origin, 1996**

| University | Total | United States | United Kingdom | Canada | Australia | Hong Kong |
|---|---|---|---|---|---|---|
| Hong Kong University of Science and Technology (HKUST) | | | | | | |
| Deans/ department heads | 15 | 14 | 0 | 1 | 0 | 0 |
| Directors/ research centers | 16 | 12 | 3 | 1 | 0 | 0 |
| Chinese University of Hong Kong (CUHK) | | | | | | |
| Full professors | 16 | 6 | 4 | 3 | 1 | 2 |
| Directors/ research centers | 10 | 4 | 3 | 1 | 0 | 2 |

**SOURCE:** National Science Board, *Science and Engineering Indicators-1998*, (NSB) 98-1 (Arlington, VA: National Science Foundation).

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# Issues in Human Resources in Science and Engineering: India

*Atul Wad*

## Introduction

India continues to produce a substantial quantity of science and engineering (S&E) personnel through its educational system and through higher education overseas. Over the last 3 decades, there has been a steady increase in student enrollment, adding up to nearly 6.5 million by 1996. However, enrollment in basic sciences has dropped to 19.6 percent (from 30 percent) of the total over this period, and there has not been a significant increase in enrollment in engineering and technology (which account for about 5 percent of the total).

In this paper, the focus is on the trends in the generation of these human resources in India and how certain important economic changes may have an impact on the career paths and opportunities for these personnel.

Current data on S&E personnel in India are limited, with the most recent sources being *Research and Development Statistics* (DST 1996) and the 1998 *Science & Engineering Indicators* report (NSB 1998) of the National Science Foundation (NSF). Nevertheless, broad implications may be drawn based on these data and analyses of current important economic circumstances. This discussion paper is based to a large extent on qualitative assessments of trends in S&E graduate education and is meant to serve primarily as a basis for further discussion and identification of areas for future research and data collection.

S&E graduate education needs to be viewed in the context of the major issues that face Indian S&E personnel and national policymakers: the impact of the dynamic growth of the information technology industry worldwide and its effects on demands for skills, the economic downturn in Asian economies (even though at this point India has not been as adversely affected as other nations in the region), and what NSF refers to as the “circulation” of human resources in S&E. Also important is the growing concern over the need for enhancing technology-based economic development and the consequent demand for enhanced involvement of S&E personnel in the productive sector.

## Generation of S&E Personnel in India

In an overall sense, India continues to produce S&E personnel at a steady rate, and currently has a stock of over 6.3 million (Rao 1998). Of these, however, only about 150,000 are engaged in research and development (R&D), mostly in governmental laboratories. The rest are either overseas or in nontechnical careers; some are in industry. Table 1 shows the growth in doctorate recipients from India (in the United States) over the period 1985-96.

As can be seen, the proportion of total Ph.D.s awarded in S&E areas has remained more or less constant, except in more recent years when it has increased somewhat. The median age for a Ph.D. has stayed somewhat stable as well, at around 29 years.

Within S&E, allocation across fields has changed. The greatest increase has been in the computer and information sciences, which accounted for 3.9 percent of total S&E doctorates in 1985 and 9.1 percent in 1996, reflecting the rapid growth in the information technologies (IT) industry and the attractiveness of this field from a career standpoint. It is noteworthy that many of the Indians in the software and hardware industries in India and overseas hold advanced degrees.

Of these, most had clear plans to stay in the United States after receipt of their Ph.D. According to the DST report, 1,082 of the 1,482 recipients in 1996 had firm plans

**Table 1. Number of Ph.D.s from India by year of award, 1985-96**

| Year | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Total | 541 | 579 | 602 | 647 | 679 | 881 | 924 | 1,072 | 1,139 | 1,289 | 1,426 | 1,481 |
| S&E (percent) | 84 | 81 | 83 | 80 | 78 | 80 | 81 | 80 | 81 | 82 | 84 | 84 |

**SOURCE:** Government of India, Ministry of Science and Technology, Department of Science and Technology, *Research and Development Statistics,* New Delhi, India, September 1996.

to locate in the United States after receiving their Ph.D.; 456 of these had definite employment plans. Most of the employers (79.2 percent) were in industry/business, and 15.8 were educational institutions. In contrast, in 1985, 47.4 percent of the employers were in industry/business and 44.5 percent were educational institutions.

To bring greater depth to this scenario, data are required on the numbers of advanced degree-holders of Indian origin who have returned to India and the location of their employment there. Typically, even though Indian Ph.D.s have tended to prefer to stay in the United States, the rapid growth in certain sectors of the Indian economy and greater overall mobility should suggest an increase in this recirculation of skills.

There is another side to the coin, however. Even though there are data that indicate that "brain circulation" is occurring for some countries such as Taiwan and South Korea, India and China still experience more "brain drain" than not. This is perhaps understood by the fairly high level of S&E personnel in India actively seeking employment. According to DST, 676,099 science graduates and 100,249 science postgraduates, as well as 152,015 engineering graduates and postgraduates combined, were on the active registers of employment exchanges in 1993. More current data are not available.

Given that economic conditions may have made it favorable for S&E personnel to return to India if they entered specific industry/business areas but that overall employment prospects for them do not seem to have improved, research is needed to determine what specific trends are emerging as a result.

This is particularly important when viewed from a national economic development perspective. Ideally, countries like India need to harness their S&E personnel and capabilities to accelerate the development process and further the development of national science and technology infrastructure, research, and training. A major channel through which this could occur is the national laboratory system (e.g., the Council of Scientific and Industrial Research—CSIR) and national teaching institutes such as the Indian Institutes of Technology (IITs). There has been considerable criticism of the extent to which mechanisms have actually made contributions to the productive sphere; it is only recently, for example, that the CSIR system has been asked to focus its energies on such efforts. This has been accompanied in many cases by budget cutbacks, which have limited the ability of national labs to offer attractive salaries and career prospects to new graduates. The upshot is that the private sector, and in particular the information technology area, is becoming a major career choice for such graduates.

This in turn is having an impact on the supply of future teachers (Rao 1998, p. 29):

> In the field of postgraduate education and research in engineering and technology the following trends are worrisome. (1) The average turnout of Master's Degree holders in engineering technology is only around 5,000 per year and this is against the capacity of more than 15,000. (2) The loss of engineering graduates to software industry is taking place on a large scale with consequences to postgraduate programmes. On account of these negative developments there is an acute shortage of teachers with postgraduate qualifications in engineering and technology. The situation is becoming one of concern as expansion in engineering education will have to go hand in hand with economic growth. (3) The number of doctorates in engineering and technology being produced annually now is only about 400 and 90 percent of them come from only a dozen institutions.

Indeed, as table 2 shows, the number of doctorates in engineering has dropped considerably over the period 1982-94.

**Table 2. Doctorate degrees awarded by field**

| Faculty | 1982–83 | 1990–91 | 1993-94 |
|---|---|---|---|
| Total............................ | 6,948 | 8,383 | 9,369 |
| Engineering/tech...... | 511 | 629 | 348 |

**SOURCE:** Government of India, Ministry of Science and Technology, Department of Science and Technology, *Research and Development Statistics,* New Delhi, India, September 1996.

In science, however, the number of doctorates has increased from 2,892 in 1982-83 to 3,505 in 1993-94. The overall total number of doctorates has also increased, rising from 6,948 in 1982-83 to 9,369 in 1993-94.

DST has compiled estimates of the total stock of engineering degree-holders by discipline; these are summarized in table 3.

| Table 3. Engineering degree-holders by field | | | | |
|---|---|---|---|---|
| Discipline/Year | 1986 | 1990 | 1995 | 2000 |
| Total...................... | 390,830 | 492,180 | 660,660 | 848,660 |
| Civil.................. | 94,540 | 11,940 | 153,160 | 186,830 |
| Mechanical........ | 108,400 | 131,200 | 164,220 | 197,980 |
| Electrical........... | 76,390 | 87,030 | 106,220 | 125,870 |
| Chemical........... | 23,660 | 27,510 | 32,300 | 37,700 |
| Telecom............ | 25,520 | 41,830 | 67,290 | 96,260 |
| Metallurgy......... | 11,960 | 13,120 | 14,880 | 16,780 |
| Automobile........ | 730 | 1,140 | 2,720 | 5,140 |
| Aeronautical...... | 1,360 | 1,530 | 1,760 | 1,950 |
| Other................. | 20,410 | 32,440 | 66,930 | 110,350 |

**SOURCE:** Government of India, Ministry of Science and Technology, Department of Science and Technology, *Research and Development Statistics,* New Delhi, India, September 1996.

The specific field of computer software and hardware is not detailed separately but is probably included within telecommunications, electrical engineering, and other.

It is perhaps worth comparing these figures with the numbers of first university degrees in S&E in India over the period 1985-95 (table 4).

| Table 4. First university degrees in S&E in India, 1985-95 | | | |
|---|---|---|---|
| Field | 1985 | 1990 | 1995 |
| All univ. degrees............ | 646,748 | 750,000 | 750,000 |
| Engineering............... | 21,088 | 29,000 | 29,000 |
| Math. & comp. sci...... | NA | NA | NA |

**SOURCE:** National Science Board, *Science & Engineering Indicators - 1998,* NSB-98-1 Arlington, VA, 1998.

Clearly, these is a general lack of available data on graduates in computer sciences (and mathematics); this is an important area in which further and more refined data collection is needed in order to better understand the changing composition of S&E degrees.

## S&E and Productivity

One of the major purposes of enhancing the quality, quantity, and proper deployment of S&E is economic development and the strengthening of the economy. Indian national science and technology (S&T) policy has always been based on this need as a central focus (along with an emphasis on self-reliance). Since independence, the generation of highly qualified scientists and engineers (and the establishment of premier educational institutions such as the IITs) have been driven by this objective. However, accomplishments in terms of concrete and positive contributions to productivity by S&T have been questionable, and one of the "negative" effects of an imbalance between the supply of personnel and the economy's absorptive capacity has been brain drain.

Today, the discussion has turned from brain drain to brain circulation, which may apply to some Asian countries more than others. Brain circulation appears to be occurring in some countries (but may change with the recent Asian economic crises). This takes place in the form of graduates returning to jobs back home, networking with colleagues in their countries of origin, and thereby creating more of a dynamic two-way flow of talents and skills between the United States and the home country.

Of paramount importance, however, is to investigate to what extent this type of circulation actually contributes to home countries' scientific and technological infrastructure (broadly defined to include research, training, policy, transfer of knowledge, etc.) and hence, in turn enhance the economic development process.

For example, considering that India is primarily an agricultural country and is the number one producer of certain commodities such as jute, sugar, fruits, and vegetables, it is—in terms of productivity—on the low end of the spectrum (Rao 1998, p. 19) (table 5).

| Table 5. Indian agricultural productivity | | | | |
|---|---|---|---|---|
| Type of Plant | Production | | Yield | |
| | Annual (1000 T) | World Rank | Yield kg/ha | World Rank |
| Jute.................... | 1,260 | 1 | 1,465 | 10 |
| Fruits/veg........... | 100 | 1 | Variable | Below 10 |
| Raw sugar.......... | 13-14,000 | 1 | 10% | Below 5 |

**SOURCE:** P. Rama Rao. "Science and Technology in India: Retrospect and Prospect." Address to the 85th Annual Session, Osmania University, Hyderabad, India, January 3, 1998.

The potential contribution of technological know-how and skills is critical in improving productivity in agriculture, a mainstay of the economy. Yet the trend in doctoral degrees awarded in agriculture from Indian universities has declined in recent years. The trend in doctoral recipients in agricultural sciences from the United States shows a similar decline, but precise data are not available (table 6).

**Table 6. Doctoral degrees awarded in agriculture in India**

| 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 |
|---|---|---|---|---|---|---|---|
| 712 | 688 | 703 | 715 | 715 | 611 | 572 | 572 |

**SOURCE:** Government of India, Ministry of Science and Technology, Department of Science and Technology, *Research and Development Statistics,* New Delhi, India, September 1996.

This is the type of trend that raises concerns for the long term. Regardless of the tremendous growth and advances in areas such as IT, and the admittedly positive implications of these for productivity improvements in all sectors of the economy, the need for basic technological capabilities that can continue to improve agricultural efficiencies is critical to the long-term economic development of the nation.

Moreover, technological capacities are required for the further processing of agricultural commodities into value-added products, the economic benefits of which are growing rapidly worldwide. Adding value to agricultural resources is a mainstay of economic development: moving up the "value chain" is central to the wealth creation process that underlies economic development. For this to occur, the country needs personnel with skills in appropriate areas—food processing, fermentation, packaging, chemical engineering, tissue culture, biotechnology, etc. With these skill sets properly harnessed, the Indian economy could build a value-added industrial base that generates wealth from its agricultural and natural resource base.

For example, there is a growing demand for high-quality flavors and extracts (essences) by the global food and beverage, aromatics, and perfume industries. Indian spices, botanicals, fruits, and vegetables are acknowledged to be very high in taste and flavor content even though yields may be low. Market demographics have been changing in recent years: there is a growing consumer demand for exotic tastes and more variety in flavors and aromatics. The growth of new markets, for example aromatherapy and organic foods, is another driver of demand.

To meet these new demands and enter these markets competitively, capabilities in new technologies that provide higher extract yields and higher efficiencies are required. These technological developments are occurring in various countries around the world (substantially in the United States), and it is essential that India develop S&E personnel with skills in these areas. Such skills must be built upon a solid foundation of training and research in the appropriate area of agricultural engineering.

An important consideration here is that technical skills by themselves may not be adequate. There has to be an appreciation of market trends (and opportunities) and incentives for S&E personnel to pursue them. The knowledge of market opportunities needs to be dealt with by appropriate modifications to the teaching/research program. Incentives for S&E personnel can only come from private industry and through national policies.

## Broader Economic Context of S&E Education

Rao (1998) makes a strong and crucial argument that the broader economic context within which scientific and engineering activities take place—including education—must be taken into consideration in all aspects of S&T policy. Of particular importance are the commercial aspects of technology. To fully capitalize on the competitive resources of the country, there is a need to focus S&T activities in such a way as to optimize the commercialization, in a competitive sense, of scientific and technological know-how.

In this regard, education in S&E must be based on a broader concept of knowledge than simply functional specialization. Of specific importance are the areas of finance, organization and management, and marketing. These are areas with which S&E personnel need to have a working familiarity. The base of such expertise, interestingly enough, may already be developing, with various government agencies involved in S&T in India becoming more involved with venture capital, technology commercialization, and market-driven approaches to S&T. The recently created Technology Development Board is one such example; its mission is to promote the commercial development of technology and mobilize the resources and inputs needed for this end.

This need is present in most sectors of the Indian economy—health, pharmaceuticals, chemicals, agriculture, telecommunications, transportation, energy, etc. The challenge for the future is to be able to identify, with some accuracy, which are the opportunity areas of the future and to develop educational programs to generate the skill sets that will be required. This is admittedly a major undertaking. Fortunately, in the United States and Europe, educational and research programs in the relevant areas already exist and can be taken advantage of by Indian students.

Another dimension of the global context is the very process of globalization itself. Corporations are becoming increasingly global in their character, and the economies of the world—as evidenced by recent economic events in Asia and Latin America—are becoming increasingly intertwined. As a result, one finds U.S. corporations with a global reach paying more attention to the recruitment of talent from the countries in which they operate and depending increasingly on skills available in these countries. This applies not only to the mainstream areas of S&E but also to the newly emerging ones, such as IT, as well. For example, nearly every major U.S. software company has established a development operation in India, with the intention of utilizing the vast and still relatively inexpensive technical resources available there. This has two effects: first, there is tremendous mobility in the IT field between the United States and India, and the number of Indians in this industry—for example, in Silicon Valley—has skyrocketed in the past decade. Second, the growth of the industry is drawing people away from other career paths in S&E, with the consequent implications for long-term economic development discussed earlier.

There is another trend that is gradually emerging that is of significance in educational terms. Indian engineering graduates, mainly from the IITs, are now being found in high-level positions in the financial sector. For example, an IIT graduate is now head of Citibank worldwide. Many of the senior staff in multilateral financial institutions, such as the International Finance Corporation and the World Bank, are Indian engineering graduates from the 1970s and 1980s. They in turn are becoming role models for future generations of engineering graduates.

In the past, for the most part, Indian students came to the United States to study S&T with a clear intention of staying in that field throughout their careers. A subtle but important change may be occurring in more recent times, in that students see an initial S&T education as a channel to a career in an altogether different area—finance, consulting, business, etc. This is not altogether a bad thing; in fact, for some time now, it has been known that few IIT graduates have stayed in engineering as a career, and have succeeded in other fields, particularly in the private sector.

In a sense, this was the original vision of the IITs: to generate Indian "technocrats" who would take on leadership roles in technology and industry, and hence contribute to the economic development of the country. As it happened, a large proportion of these graduates accomplished this, but overseas. Whether this trend is changing and more engineering graduates are returning to India after their education (and perhaps a brief career) overseas is an issue that needs to be explored.

From the perspective of organizations concerned with S&T, such as NSF and national S&T agencies, these trends raise an important question. To what extent is advanced S&T education to be seen as precisely that, preparing students for careers in their respective fields of S&T, and to what extent is it an intellectual training ground that prepares these students for a broader panorama of career options? And which of these two is the more important from a long-term economic development perspective?

This issue has several implications in terms of financing of graduate education, establishment of new institutions, and the types of support that can or should be provided to students.

Furthermore, if indeed one result of this trend is a downward pressure on the supply of trained S&T graduates further aggravated by the poor employment prospects in S&T areas, measures need to be taken to address this issue. Rao (1998) points to the "assured placement scheme" of the Department of Atomic Energy in India, which first brings graduates into their own training school where they are coached for a year in an advanced field of importance to the department. They are then assured of a job at the end of the year. A similar approach could be adopted by private industry in India as well.

## Recent Economic Crises

Some mention has been made of the impact of the recent economic crises in Asia on the ability of students from these countries to pursue advanced education in the United States and on the circulation process.

The most immediate effect of the Asian economic crises would be on the ability of foreign students to afford education in the United States without financial support of some kind. There is anecdotal evidence that this is taking place (Honan 1998), partly due to rising costs of education in the United States and partly because other countries are recruiting students more vigorously. Nine of the 10 countries that send the greatest number of students to the United States are Asian (Canada is the only non-Asian country). Additionally, the financial crisis has forced many Asian students to seek cheaper housing, get part-time jobs, and transfer to colleges in other countries. To what extent this overall trend is reflected in trends in S&E graduates requires research.

The Asian crisis would have had a greater impact on the plans of students from the worst affected countries (South Korea, Thailand); its effects on Indian students may have been less. However, the India rupee has also been losing value steadily, which is likely to have an impact over time. NSF analysis of foreign doctoral recipients and their stay rates in the United States shows that India and China have the highest rates; this is likely to continue for the reasons outlined earlier.

The Asian economic crisis does highlight one issue that bears deeper consideration—the relationship between productivity-driven economic considerations and the demand for and behavior of S&E graduates. The argument has been made that a major reason for the downturn in these economies was a lack of long-term and targeted investment in productive wealth-generating efforts that would add value to local resources and generate sustainable competitive industries. Instead, much of the investment was going toward speculative ventures, real estate, and debt financing of noncompetitive industries, where the need for highly trained S&E personnel is low. One would then expect that most of the jobs and opportunities for S&E personnel would be in academia and the government. In India, this has certainly been the case, given the low demand for S&E personnel in the private sector. Yet it is in the private sector, where their knowledge can be applied to the development of competitive technology-based enterprises, that their full value should be realized—at least in terms of contributions to productivity.

Furthermore, in an economic downturn, not only does private industry cut back on R&D expenditures, but the government typically also cuts budgets in S&T-related areas. All of this has the net effect of reducing even further the demand for S&E personnel in S&E careers. The only major source of demand under these conditions would be overseas employers (such as in the United States), and that would be subject to the sector priorities in those economies. Thus, the growth in the information industry in the United States (and its counterpart in India) is drawing an increasing number of Indian engineers because of both its economic attractiveness and the decline of opportunities in other fields.

Thus we have a downward spiral effect where past economic policies, based on a lack of focus on the role of S&T to economic growth (and the consequent low demand for such skills), produce conditions that further deteriorate this demand. This subject—the relationship between economic policies and demand conditions for S&E personnel—requires further investigation.

In the past, the implications of broad economic trends and conditions have not been stressed in the analysis of educational needs in S&E and patterns of S&E education. In today's more integrated and dynamic global economy, it would be prudent to bring these factors into an analysis of this critical issue. This in turn means broadening the disciplinary base for the study of S&E education to include expertise in technology and economic development, economic policy, technology commercialization, and competitive strategy, among others.

## Issues for Further Research

Clearly, there are a number of issues that need to be addressed to develop a more current and accurate understanding of the situation today and in the future with respect to S&E graduate education. In the case of India, the lack of data is in itself a problem, but the types of data that need to be gathered and the relationships that need to be studied also need to be reassessed. Some of these are summarized below.

### Comparative Data on Distributions Across S&E Fields in the United States and India

Of particular interest here would be the changes in distribution between new fields (e.g., IT) and traditional areas, as well as distribution changes within fields (e.g., food processing). In addition, data on distribution between the United States and India in terms of degree recipients, and the employment locations of both groups by field, would provide better insight into current trends.

## Data on Economic Conditions and Employment Choices of S&E Graduates

The correlation of broad economic indicators, such as those used by the World Bank and the United Nations Development Programme, as well as assessments of the competitiveness of different countries (e.g., the *World Competitiveness Report*), with employment paths and patterns of demand for skills in S&E would provide very useful data for future education planning and reform. Of importance here is the need for a conceptual framework that builds upon analytical principles in economic development and allows propositions to be developed about the relationships between economic development dynamics and career patterns and choices of S&E personnel in India.

## Time-Series Data on Career Paths of Indian Scientists and Engineers

As discussed earlier, many Indian engineering graduates are now in senior positions in other fields—business, consulting, finance, etc. This is an important trend both in terms of how we evaluate graduate S&E education and how we develop new educational programs and policies. Just as the IITs were established based on a "technocratic" vision, there may be an emerging need for educational institutions to integrate S&E with such areas as entrepreneurship, innovation, economic development, and finance to create a new generation of what the United Nations (UN) refers to as "techno-entrepreneurs" for the modern global economy.

## Trends in Sources of Funding

Patterns of funding and the composition of sources of funding for R&D, graduate education, and training is another area for more thorough data collection. This is particularly important because there is an ongoing shift away from public sector funding for R&D and a growing emphasis on technology commercialization. Of interest would be changes in the distribution between Indian and U.S/foreign sources of funding and the types of support being made available from these sources.

## Impact of S&T Policies on Graduate Education

During the 1970s, considerable emphasis was given to the role of S&T policies and policy mechanisms in strengthening S&E capabilities in developing countries. The UN's Vienna Program outlines eight areas where policies needed to be developed in S&T; one is human resources. During the 1980s and 1990s, there was a reduced emphasis on S&T policies, but it may now be useful to assess the impact of the S&T policies developed and implemented by countries such as India on the current situation with respect to S&T human resources.

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# GRADUATE EDUCATION REFORM AND INTERNATIONAL MOBILITY OF SCIENTISTS IN JAPAN AND RELATED INFORMATION FOR KOREA

*Shinichi Yamamoto*

## INTRODUCTION

Since the establishment of a system of higher education in Japan at the end of the 19th century, it has been one of the driving forces in leading Japan into industrialization and modernization. However, Japan has experienced great economic and social changes that now demand subsequent changes in the university system.

"University reform" is the key concept in understanding the current situation of higher education in Japan. The Basic Plan for Promotion of Science and Technology, which has just been initiated by the government, will be a great boost for the movement to reform university research. Korea, one of Japan's neighbors, is also experiencing a similar kind of reform movement affecting its university and research systems.

Universities and colleges have played several roles in Japan: training researchers, teachers, and other types of professionals; carrying out research and development; and identifying prospective young people who might later play an important role in Japanese society. The character of these roles, however, is now changing greatly due to the massification of higher education and the increased sophistication of research in science and technology. The research and research training functions of universities need to be reevaluated and improved, while also responding to various educational demands by students of a mass higher education system in which more than 47 percent of the 18-year-old population now participates. It has become difficult for each individual institution to respond to these needs at the same time.

Within this changing environment, some reforms that can now be observed are competitive allocation of research funds, expansion of graduate training accompanied by new financial aid programs, encouragement of research cooperation with industry, and restructuring of research units at major universities. After discussing the reforms taking place in graduate education in Japan, a brief description is here given of recent trends in graduate education in Korea.

## NATURE OF GRADUATE EDUCATION REFORM IN JAPAN

Necessary reforms in graduate education have been discussed since the early 1970s, based on the idea that the system in Japan is very weak and inclined to train future academics rather than other types of professionals. The Ministry of Education, Science, Sports, and Culture (hereafter referred to as Monbusho) began introducing more flexibility through systemic reforms; it has devoted much effort to expanding the capacity of graduate schools and creating new programs at many national universities. A feature of graduate education policy recently introduced by Monbusho is a more competitive mode for obtaining research grants and other kinds of resources. For example, special competitive funds are made available both for graduate programs and graduate students. New types of fellowships fund individual prospective students, while other special funds provide institutional support for graduate programs. The effects of these policies will be seen in the near future.

Today, all national universities in Japan, as well as two-thirds of the private universities, have graduate programs. Graduate enrollment currently exceeds 170,000, including about 80,000 in science and engineering programs. This is more than 10 times the 1960 enrollment. For science and engineering, the number of students is 23 times larger.

## MASSIFICATION OF HIGHER EDUCATION AND THE DECLINE IN THE POPULATION OF 18-YEAR-OLDS

The research environment at universities has changed radically over the past years. The most important change has been the "massification" of higher education, which has made the traditional notion of the unity of research and teaching difficult to maintain. The reform and expansion of graduate education in Japan cannot be understood without mentioning the trend toward massification of higher education at the undergraduate level. Graduate education has been recognized (by university faculties as well as by the government and industry) as a crucial device for avoiding problems, such as the lack of balance between research and teaching, caused by the massification of undergraduate education.

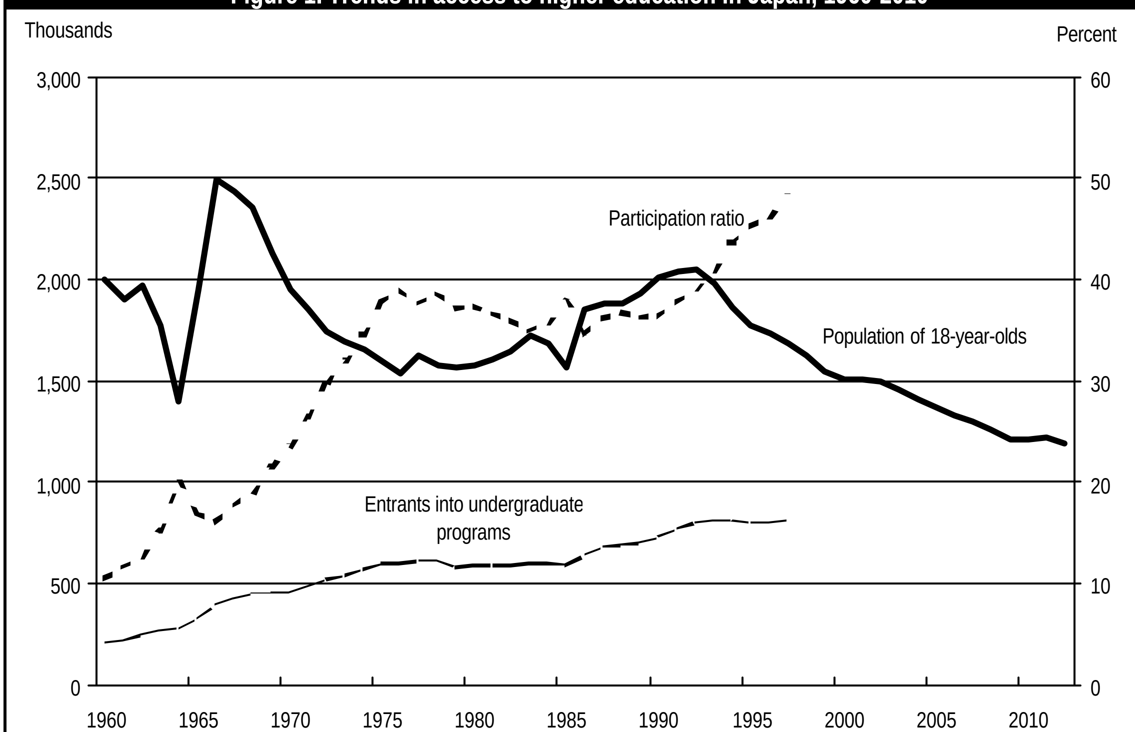
Japan experienced its first period of rapid growth in higher education after World War II in the 1960s and early 1970s. The participation ratio of the 18-year-old population in higher education grew rapidly from only 10.3 percent in 1960 to 38.6 percent in 1976 (figure 1). This growth was caused by various factors (Yamamoto 1997); among them, people's desire for higher education based on the belief that it would bring great personal benefit and the government's intention to expand the scale of higher education in science and engineering in response to the need for economic growth. Due to these factors, the proportion of science and engineering students in total enrollment in undergraduate programs grew from 18 percent in 1960 to 23 percent in 1976.

By that time, it was realized that massification brought not only growth of higher education in terms of number of students but also a radical change in the character of the system. Higher education was no longer for the "elite" but was available for the masses. The demand for education created a diversified system of institutions, ranging from the highly academic to the extremely practical.

In response to this rapid massification and qualitative change in higher education, Monbusho initiated a new policy that was intended to control the quantity and improve the quality of university education in the mid-1970s. Growth in the participation ratio flattened out, and enrollment also stopped growing. This policy, however, actually protected the existing higher education system; real university reform did not begin until the 1990s.

The second stage of massification started at the beginning of 1990s. The participation ratio of 18-year-olds grew again, from 36.3 percent in 1990 to 47.3 percent in 1997. This time, the share of students in science and engineering did not change but remained at around 23 percent. This rapid regrowth was triggered by an increase in the population of 18-year-olds in the late 1980s. This regrowth mechanism can be explained as follows: each university and college tries to expand enrollment when the population of 18-year-olds grows; the government also encourages each institution to accept more students because it is afraid of an increase in the number of people who cannot enroll in universities and colleges. This growth in capacity at each institution encourages 18-year-olds to

**Figure 1. Trends in access to higher education in Japan, 1960-2010**




**SOURCE:** The Monbusho Survey of Education.

attend universities and colleges at rates greater than the government anticipated, just as the "multiplier" used in explanations of economic growth. With a mass higher education system, people tend to go to college because their neighbors do.

This second stage of massification, however, was followed by a serious problem. As shown in figure 1, a steady decline in the 18-year-old population—from 2.05 million in 1992 to 1.20 million in 2009—will considerably lower the potential higher education enrollment. Except for a few prestigious institutions, most universities will have to consider how to deal with this future shortage of applicants and how to attract students.

Along with the massification of higher education, a growing number of people have complained about the content of education. Teaching tends to be concentrated on academic material, while many students prefer to take practical courses they think will be useful in future jobs outside academia. Another difficulty is a perceived decline in student interest in learning. Many students who might not have enrolled in higher education 2 decades earlier are not accustomed to studying abstract material in academic language. Universities must respond to this more diversified student population and improve teaching techniques and curriculum. So-called "faculty development" (FD) has become a fashionable phrase in Japan when discussing the improvement of teaching. Along with FD, universities are being forced to reform in response to this new situation, and to attract and retain students.

## The System of Graduate Education in Japan

The current graduate education system in Japan has been developing since its introduction after World War II. Enrollment in graduate education, though much smaller than in the United States and major European countries, has grown more rapidly than undergraduate enrollment during this period. Now, approximately 10 percent of students (26 percent in science and engineering) who finish undergraduate programs advance to graduate programs.

Graduate schools offer two kinds of programs—a 2-year master's degree program and a 3-year doctoral program. The doctoral programs generally admit students who finish a master's degree program. Enrollment in graduate school generally requires the successful completion of a bachelor's degree. However, a recent reform enables each graduate school to admit prospective students who have not yet finished their undergraduate program and to grant degrees to those who have completed a shorter coursework program.

Japanese doctoral degrees are classified into two categories. One is the "coursework doctorate" (university-based doctorate), granted to those who finish 3 years of coursework and write a doctoral thesis. The other is the "thesis doctorate" (*Ronbun* doctorate), granted to those employed in industry or others who submit a thesis (based on their industrial research) to graduate schools and pass an examination. The level of both doctorates is the same according to the definition in Monbusho's Degree Order. However, a thesis doctorate has tended to be recognized as a "grand doctorate" rather than as an alternative to a coursework doctorate. Granting doctorates has sometimes been regarded in academic circles as praise for esteemed scholars for their exceptional work. This notion has tended to prevent academics from viewing doctorates as a "license" for future researchers and has made doctorates difficult to obtain for young people who are in doctoral programs, especially in the humanities and social sciences.

In the sciences, the number of coursework doctorates has traditionally exceeded the number of thesis doctorates; in engineering and medicine, on the other hand, thesis doctorates have exceeded coursework doctorates. With the expansion of university doctoral programs, however, the proportion of university-based engineering degrees has been increasing. By 1992, more doctoral engineering degrees were earned for research within university laboratories than in industrial research laboratories. This increase was partly due to the fact that each graduate school in engineering had encouraged people who had once enrolled in a master's program to enroll in shorter graduate programs (mostly 1 year) to obtain a doctorate.[1]

Under the Japanese doctorate system, there is no clear distinction between a Ph.D. and a professional doctoral degree. Recipients of either type of degree are called "doctor," although credentials require indication of a specialty and the name of the university that granted the degree.

[1]Under the current Japanese system, the minimum coursework requirement for a doctorate is 3 years, including master's degree coursework. If a person has previously enrolled in a 2-year master's program or has equivalent ability, the minimum coursework requirement is 1 year.

Graduate schools are quite separate from undergraduate programs. This structural distinction is one of the unique features of the Japanese university system, in contrast to European systems where undergraduate and graduate structures are not so clearly distinguished. The U.S. graduate education system is funded by individual grants; this is unlike Japan's system, where Monbusho provides general university funds to the graduate programs at national universities. Some European countries indicate that they are now looking at the U.S. system of graduate education. One of the biggest problems is that graduate schools are much smaller than undergraduate departments. Most faculty members want to teach at graduate schools while, in reality, they usually have their affiliation with undergraduate departments and are heavily involved in undergraduate teaching. Faculties have long claimed that graduate schools should be further expanded.

Japanese graduate schools are now aiming to train professionals with advanced specialized skills, as well as train researchers to work in academia and other institutions. Most efforts, however—especially in the humanities and social sciences—have been devoted to training academic researchers. People who want to work for business and government have tended to end their studies at the undergraduate level. This relates to the fact that leading Japanese companies each year have recruited new bachelor's degree recipients of potential ability and given

**Table 1. Master's and doctoral degrees by field in Japan**

| Field | 1991 | 1992 | 1993 | 1994 | 1995 |
|---|---|---|---|---|---|
| | **Master's degree** | | | | |
| Total | 29,550 | 33,293 | 37,213 | 42,015 | 47,525 |
| Humanities | 2,348 | 2,473 | 2,749 | 2,947 | 3,413 |
| Social sciences | 2,672 | 3,095 | 3,613 | 4,169 | 5,135 |
| Science | 3,204 | 3,504 | 3,862 | 4,457 | 4,946 |
| Engineering | 14,346 | 16,309 | 18,198 | 20,352 | 22,610 |
| Agriculture | 2,028 | 2,372 | 2,622 | 2,971 | 3,136 |
| Health | 1,316 | 1,403 | 1,659 | 1,749 | 1,871 |
| Home economics | 168 | 195 | 221 | 201 | 290 |
| Education | 2,436 | 2,666 | 2,850 | 3,204 | 3,699 |
| Arts | 674 | 730 | 743 | 884 | 985 |
| Others | 358 | 546 | 696 | 1,081 | 1,440 |
| | **Doctoral degree** | | | | |
| Total | 10,885 | 11,576 | 12,486 | 13,044 | 13,632 |
| Coursework doctor total | 4,779 | 5,134 | 5,718 | 6,203 | 6,979 |
| Humanities | 42 | 56 | 90 | 133 | 147 |
| Social sciences | 67 | 90 | 88 | 123 | 174 |
| Science | 586 | 638 | 761 | 811 | 908 |
| Engineering | 983 | 1,184 | 1,432 | 1,613 | 1,925 |
| Agriculture | 385 | 376 | 446 | 508 | 587 |
| Health | 2,503 | 2,624 | 2,670 | 2,736 | 2,886 |
| Education | 25 | 21 | 25 | 24 | 32 |
| Others | 188 | 145 | 206 | 255 | 320 |
| Ronbun doctor total | 6,106 | 6,442 | 6,768 | 6,841 | 6,653 |
| Humanities | 117 | 149 | 171 | 175 | 198 |
| Social sciences | 133 | 153 | 195 | 178 | 184 |
| Science | 306 | 371 | 407 | 324 | 335 |
| Engineering | 1,111 | 1,178 | 1,351 | 1,396 | 1,372 |
| Agriculture | 485 | 448 | 476 | 500 | 521 |
| Health | 3,853 | 4,032 | 4,042 | 4,125 | 3,896 |
| Education | 24 | 39 | 47 | 52 | 53 |
| Others | 77 | 72 | 79 | 91 | 94 |

**SOURCE:** The Monbusho Survey of Education.

them long-term in-service training as future managers. Companies do not seek people with specific or advanced skills.

Thus, advancing to graduate programs instead of getting a job after obtaining a bachelor's degree has not been attractive except for those who intended to be university researchers. A few exceptional cases are those holding master's degrees in engineering or doctoral degrees in medicine. The reason for the success of master's programs in engineering was the growing demand for specialized skills in this field when Japan's economy was increasing rapidly. This economic growth triggered policymakers and industry to demand expanded master's programs in engineering. Once prospective students regularly advanced to graduate programs, having a master's degree in engineering gradually became essential for employment in mainstream industry. Today, universities that offer master's degree programs train students intensively for 3 years from their final years in undergraduate programs until the end of the master's course.

Graduate enrollment differs by institution type (national, local, public, and private). The majority of students take their undergraduate courses at private institutions, while national universities exceed others in the scale of graduate education. Similar differences exist among the disciplines (table 2). In the humanities and social sciences, most students leave their institutions with bachelor's degrees; graduate education is very minor compared with the huge scale of undergraduate programs. Advanced research activities in this group are highly concentrated in a few institutions. More students enter graduate programs in science and engineering. Master's programs in engineering are regarded as the most successful case of graduate education in Japan. Doctoral enrollment in this field is also much greater than in the humanities and social sciences.

## Expansion of Graduate Education

As mentioned above, until the late 1970s, the function of the Japanese graduate education system had been mainly the research training of future academics. In some areas, such as engineering, growing enrollment had gradually changed the character of graduate education—i.e., shifting it from an emphasis on academic research training to professional training. Thus, in the 1970s and 1980s, Monbusho discussed and introduced systemic reforms.

Although graduate education aims at both academic research and professional training, it has been regarded as an important locus of research activity. Due to the massification of university education, concerns about university research have shifted from undergraduate departments to graduate schools. Graduate schools seem to be a sanctuary not only for faculty members who seek the unity of research and teaching, but also for policymakers who regard university research as an engine for economic growth and technological innovation.

**Table 2. Number of students finishing each program, 1997**

| By type of institution | Level | | | |
|---|---|---|---|---|
| | Undergraduate | Master's programs | Doctoral programs | |
| Total | 524,512 | 50,430 | 9,860 | |
| National | 104,100 | 31,025 | 7,024 | |
| Local | 15,808 | 2,000 | 446 | |
| Private | 404,604 | 17,405 | 2,390 | |
| **By field** | **Level** | | | |
| | Undergraduate | Master's programs | Doctoral programs[a] | Doctorates granted[b] |
| Total | 524,512 | 50,430 | 9,860 | 12,031 |
| Humanities and social sciences | 299,324 | 4,234 | 1,570 | 522 |
| Science and engineering | 136,773 | 26,393 | 4,359 | 4,663 |
| Health | 23,571 | 2,033 | 3,370 | 6,480 |
| Others | 64,844 | 17,770 | 561 | 366 |

[a] Number of students who finished coursework in that year.

[b] Number of doctorates granted in that academic year including both coursework doctorates and ronbun doctorate. It can be seen that there are many students who leave their coursework without receiving a doctorate in the humanities and social sciences.

**SOURCE:** Monbusho, Basic School

The growing number of graduate students, especially in engineering, has reflected the new expectations of the industrial sector. Master's degree programs have grown far more rapidly than those at the undergraduate level. The proportion of students who advanced from undergraduate to master's degree courses was low even in engineering during the 1960s and early 1970s. By 1996, however, it reached nearly 25 percent; at the University of Tokyo, for example, 69 percent of undergraduate students at the School of Engineering advanced to graduate courses in that year. On the other hand, in the humanities and social sciences, this ratio has remained low.

Although enrollment differs by discipline, graduate education has been closely connected to research intensity at Japanese national universities and is influenced by university finances. The level of general university funds allocated for each national university from Monbusho differs greatly for universities with master's and doctoral programs. The amount of general university funds allocated for each research unit (*Koza*) that deals with doctoral programs is more than two times greater than that of any type of research unit that has no relation to graduate education (*Gakkamoku*). For private universities and local public universities, doctoral programs bestow a prestigious status upon neighboring institutions, even if they do not attract enough students into their graduate schools.

Thus, graduate education has been expanding not only by responding to growing demand, but also due to the desire of faculties to increase their funding and status. Today, all national universities have at least master's

## INCREASING FLEXIBILITY IN JAPANESE GRADUATE EDUCATION

A number of changes have been made with the aim of bringing greater flexibility to the graduate school system since the late 1970s:

1. The aims of doctorate courses have been expanded to include not only the traditional goal of training researchers to work in universities and other institutions, but also the training of professionals with advanced specialized skills that enable them to contribute to various sectors of society.

2. It has become possible to establish evening graduate courses to meet the needs of workers.

3. Graduate schools are now able to reduce the required duration of study for students of exceptional ability.

4. Students in master's degree courses are now able to receive research guidance in other universities and institutions for up to 1 year when this is deemed to be of educational or research benefit.

5. To provide a way for students who show exceptional aptitude for research to begin graduate studies earlier than usual, the system has been altered to allow such students to proceed directly to master's degree course studies after completing the third undergraduate year.

6. Students who have completed their undergraduate programs and have been involved in research at universities or research institutions for at least 2 years are now deemed qualified to enter the upper division of doctorate courses even if they have not completed master's degree courses.

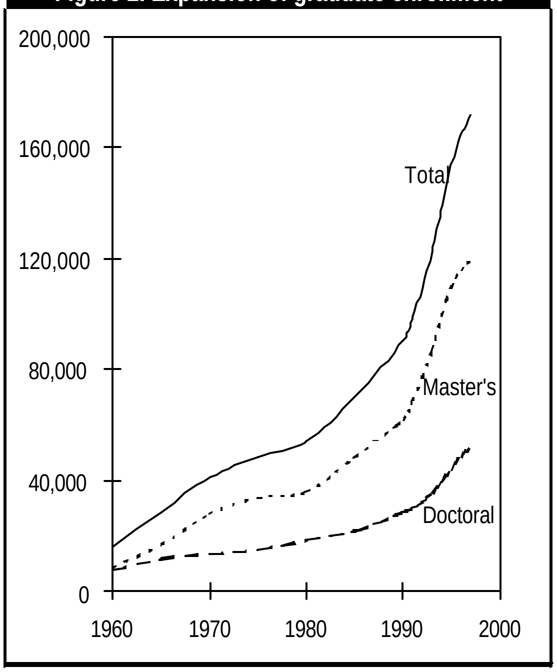
7. In master's degree courses designed primarily to train professionals with advanced specialized skills, the requirements concerning degree theses have been changed to enable the thesis requirement to be waived at the discretion of the graduate school when this is deemed appropriate from an educational viewpoint.

8. People with outstanding knowledge and experience in specialized fields and with advanced abilities in education and research can now be considered qualified to be graduate school teachers. The aim of this change is to attract human resources from nonacademic sectors of society so that people with exceptional knowledge and experience in specialized fields can contribute to graduate education and research.

**SOURCE**: Monbusho (1996).

programs and 80 percent have doctoral programs. As for private universities, 19 percent have master's programs and 47 percent have doctoral programs; just 34 percent have only undergraduate programs. The annual growth of graduate enrollment in Japan was the highest among industrialized countries in the world. While the United States experienced about 1.8 percent annual growth during the 1980s, Japan's graduate enrollment increased by 5.6 percent.

**Figure 2. Expansion of graduate enrollment**



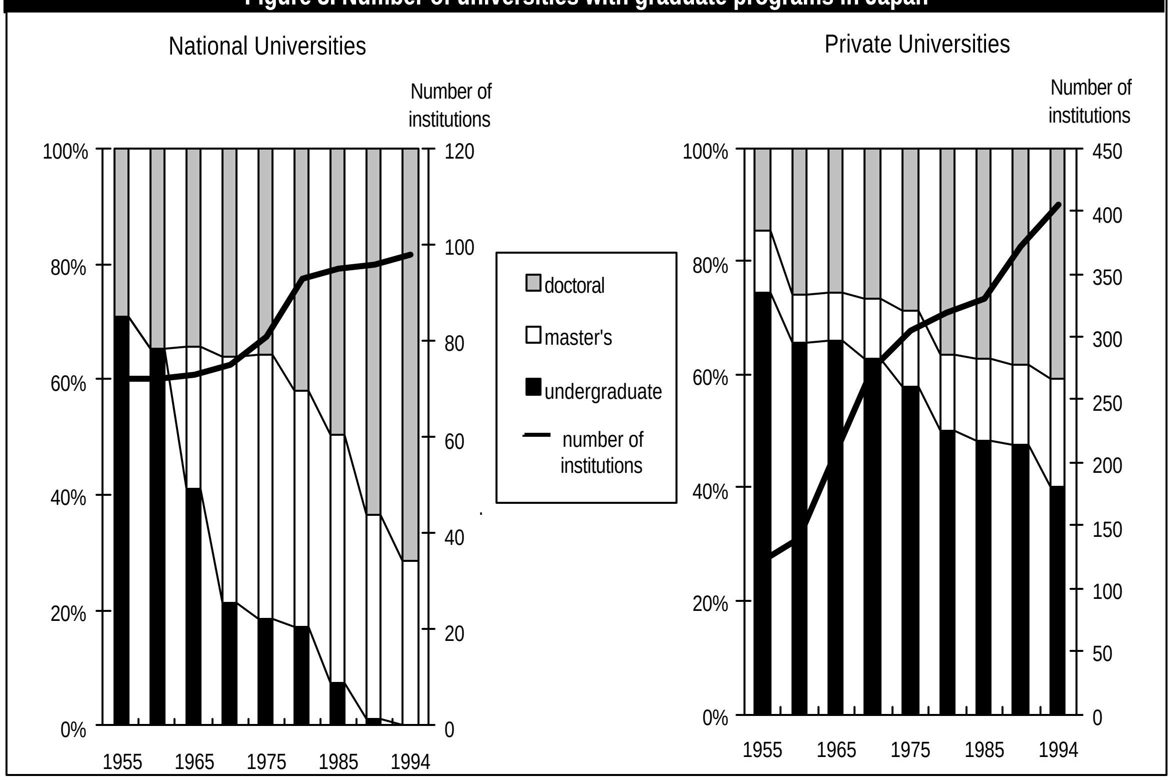

**SOURCE:** Monbusho, Basic School Survey.

**Table 3. Enrollment in graduate programs in Japan: master's and doctorate, by field, 1960-97**

| Field | 1960 | 1970 | 1980 | 1990 | 1997 |
|---|---|---|---|---|---|
| | Master's programs | | | | |
| Total | 8,305 | 27,714 | 35,781 | 61,884 | 119,406 |
| Humanities | 2,870 | 5,157 | 5,469 | 6,009 | 10,729 |
| Social sciences | 2,370 | 4,607 | 4,050 | 6,366 | 15,380 |
| Science | 987 | 2,983 | 3,741 | 6,484 | 12,109 |
| Engineering | 1,223 | 10,251 | 14,864 | 28,399 | 51,277 |
| Agriculture | 372 | 2,063 | 2,546 | 4,046 | 6,943 |
| Health | 140 | 909 | 1,497 | 2,710 | 4,909 |
| Other | 343 | 1,744 | 3,614 | 7,870 | 18,059 |
| | Doctoral programs | | | | |
| Total | 7,429 | 13,243 | 18,211 | 28,354 | 52,141 |
| Humanities | 1,016 | 1,876 | 2,860 | 3,594 | 5,592 |
| Social sciences | 894 | 1,727 | 2,430 | 2,654 | 4,830 |
| Science | 900 | 2,263 | 2,589 | 3,067 | 5,831 |
| Engineering | 391 | 2,356 | 2,358 | 4,315 | 10,847 |
| Agriculture | 339 | 839 | 1,095 | 1,742 | 3,632 |
| Health | 3,709 | 3,769 | 6,191 | 11,794 | 17,187 |
| Other | 180 | 413 | 688 | 1,188 | 4,222 |

**SOURCE:** Monbusho, Basic School Survey.

**Figure 3. Number of universities with graduate programs in Japan**




**SOURCE:** The Monbusho Survey of Education.

# The System for Supporting, Training, and Employing S&E Graduates in Japan

## Research Funding for Graduate Education

The growth of general university funds was almost frozen in Japan during the 1980s, due to the governmental budget deficit problem. This situation caused serious problems in graduate education because it had long been maintained by general university funds. However, revitalization of university research was considered critical in promoting advanced research and economic competitiveness. Monbusho also increased other types of research funding other than general university funds. These funds are not formula-based but are provided on a competitive basis. Thus, the structure of university research funding has changed greatly over the last several years. Special funds have been set up for graduate schools (on an institutional basis) as well as for new fellowships for doctoral students and postdoctoral researchers (on an individual basis).

Special budgetary mechanisms are available for graduate schools that are expected to produce outstanding educational or research achievements or that are actively involved in new ventures. In fiscal year 1987, Monbusho established a system for subsidizing advanced equipment for graduate schools with the aim of achieving rapid improvement in the conditions of graduate education and research. Under this system, funds are made available to graduate programs that generate excellent educational and research results. The funds are used to install advanced educational facilities needed by scientific fields and educational activities. In fiscal year 1995, the government allocated 6,343 million yen for this purpose.

A special expenditure system, the *Kodo-ka* fund, was established in fiscal year 1992 to give priority to the advancement of education and research, especially at graduate schools, through support of educational and research activities, including joint research, research exchanges, the use of teaching assistants, and international exchanges. In fiscal year 1995, 9,981 million yen were allocated for this purpose.

The aim of these new policies, along with a growing amount of competitive grant-in-aid programs (*Kaken-hi*), is to give additional resources to selected schools and scholars whose research quality and performance are outstanding. A new funding program, Research for the Future, which began in 1996 and is managed by the Japan Society for the Promotion of Science (JSPS), is funded through capital investments made by the Japanese government to promote and expand the frontiers of scientific research.[2] Funding is decided by the JSPS committee after designation of the specific research fields to be pursued.

In addition, some universities, such as the University of Tokyo, have recently shifted their research units (*Koza*) from undergraduate departments to graduate schools (*Juten-ka*). By doing so, they have succeeded in increasing their research funding by 25 percent from Monbusho. The Center of Excellence program is another example of selective allocation of resources. This program aims to establish a superior research base within a university, and Monbusho provides active support to those institutions recognized as centers of excellence. As a result, the university funding structure has greatly changed from relying on general university funds toward a reliance on specific and competitive funds.

**Table 4. Major funds allocated to national universities**

| Type of Funding | Million yen | | |
|---|---|---|---|
| | 1987 | 1992 | 1997 |
| General university fund | 97,824 | 117,873 | 154,052 |
| Grant-in-aid | 45,080 | 64,600 | 112,200 |
| Contract research from industry[a] | 22,361 | 48,184 | 52,783 |
| Contract research from government | 5,451 | 9,449 | 41,853 |

[a] Donations in 1997 included large capital investment funds.

**SOURCE:** The Monbusho Survey of Education.

## Financial Support for Graduate Students and Postdoctoral Researchers

Financial support for graduate students and postdoctoral researchers is important for research training. For graduate students, scholarship loans provided by the Japan Scholarship Foundation (JSF) have played the

[2]Many efforts have been undertaken to improve the difficult economic situation in Japan. Research as investment has emerged under these circumstances.

biggest role.[3] These loans enable students who lack financial resources to attend graduate schools. More than 40 percent of master's degree program students, and more than 60 percent of doctoral program students, used these loans in the 1970s. Although the growth of JSF scholarship loans did not follow the expansion of the student population (those figures have now declined to 30 percent of master's students and 50 percent of doctoral students), the loans provide basic financial support for graduate students. Students who, upon graduation, are employed in universities or related institutions as researchers for some years do not need to return their scholarship loans.

In 1985, Monbusho established a new and more competitive fellowship program for young researchers, Fellowships for Japanese Young Scientists. With the aim of cultivating young researchers who will conduct innovative and trail-blazing research, this fellowship program provides a limited number of promising young researchers with fellowships and research grants so as to allow them to concentrate on their research, which they conduct in laboratories or under supervising researchers of their choice for a specified period (2 to 3 years). This new fellowship, which is administered by the JSPS, is provided for graduate students and postdoctoral researchers on a highly competitive basis. In fiscal year 1997, 2,420 doctoral students and 1,070 postdoctoral researchers were granted this type of fellowship. Thus, competitive funding for individuals has been promoted.

Under the JSPS fellowship program for young Japanese researchers, postdoctoral fellows receive 354,000 yen (approximately US$3,000) a month, and doctoral students receive 202,000 yen (US$1,700) a month. Research funding of up to 1.5 million yen is also provided. The JSF provides scholarship loans of 83,000 yen a month for master's degree course students and 115,000 yen a month for doctorate course students. In addition to the fellowship, other types of support are provided through a teaching assistant program and a research assistant (RA) program. Unlike the U.S. system, the RA is directly funded by institutions without a direct link to particular research grants.

As part of the promotion of the Program to Support 10,000 Postdoctorals, which is included in the Science and Technology Basic Plan of 1996, these new kinds of competitive support devices will be expanded not only by Monbusho, but also by other governmental agencies, including the Science and Technology Agency. The target amounts of annual support differ greatly (table 5).

**Table 5. Main financial support for graduate students and post-doctoral researchers in 1998**

| Sources/mechanisms of support | Graduate students | | Post-doctoral | Annual amount of support (1,000 yen) |
|---|---|---|---|---|
| | Master's | Doctoral | | |
| Total enrollment[a] | 105,079 | 38,343 | | |
| **Monbusho related** | | | | |
| JSF scholarship loans[b] | 27,210 | 19,750 | NA | MC:996, DC:1,380 |
| JSPS fellowships | NA | 2,440 | 1,330 | DC:2,424, PD:4,248 |
| Teaching assistantships | 3,538 | 6,853 | NA | MC,DC: 528 |
| Research assistantships | NA | 2,562 | NA | DC:1,056 |
| Other | NA | NA | 2,360 | NA |
| **STA and other ministries** | | | | |
| Fellowship from STA[c] | NA | NA | 1,087 | from 3,240 to 7,488 |
| Fellowship from MITI[d] | NA | NA | 133 | 8,640 |
| Other | NA | NA | 1,422 | NA |

[a] Japanese students only.

[b] JSF: The Japan Scholarship Foundation is a JSPS-like special public organization under the umbrella of Monbusho.

[c] STA: Science and Technology Agency.

[d] MITI: Ministry of International Trade and Industry.

**KEY:** NA = not applicable

MC=Master's course, DC=Doctoral course, and PD=Postdoctorate.

**SOURCE:** The Monbusho Survey of Education.

[3]Although scholarships are not considered loans in U.S. terminology, Monbusho considers them so because JSF scholarships (*Shogaku-kin*) should be returned (with some exceptions) under the Japanese system.

## Employment

The labor market for master's students has been generally satisfactory, especially for engineering students. These are hired by various kinds of industries and are playing a key role in the growth of industry and the economy. In contrast, the labor market outlook for doctoral students is not optimistic. One of the biggest markets for doctoral students continues to be the academic sector. This market is going to shrink because of the decline in the population of 18-year-olds. In addition, current economic difficulties make this matter worse because industries are hesitating to hire doctoral degree-holders. The labor market in industry has tended to be in specific fields. Getting a job in industry has continued to be difficult for doctoral students in the humanities and social sciences. Furthermore, the salary for Ph.D.s is almost the same as for people who finish undergraduate programs and enter employment 5 years earlier—that is, a bachelor's degree recipient's salary increases to that of a Ph.D. if he or she continues to work for 5 years at the same company instead of studying at graduate schools for 5 years to get a doctorate.

A March 1997 survey (table 6) of the careers of students who had completed graduate courses showed that of the 50,430 who had completed master's degree courses, 7,992 entered doctorate programs, while 34,223 entered employment. The main industrial sector in which graduates were employed was manufacturing (17,117). A total of 9,860 people had completed doctorate courses. Of these, 6,231 (63.2 percent) entered employment. Although industry was a major employment sector, getting a job at a university was the leader in many fields.

Demand for graduates of master's degree courses in science and engineering is especially high, but there has been a steady rise in demand for graduates in the humanities and for graduates of doctorate courses. There is evidence, however, that society still does not always place a high enough value on graduate school education. Moreover, not all graduate schools have developed educational programs that offer attractive content and provide an appropriate response to current demand.

**Table 6. Employment of graduate students, 1997**

| Field | Total | University teaching | Industry total | Manufacturing[a] | School teacher | Health related | Further study | Other[b] |
|---|---|---|---|---|---|---|---|---|
| | | | | **Master's** | | | | |
| Total | 50,430 | 536 | 31,073 | 17,117 | 2,080 | 534 | 7,992 | 8,215 |
| Humanities | 3,723 | 50 | 616 | 72 | 227 | 25 | 1,149 | 1,656 |
| Social science | 5,611 | 58 | 2,289 | 320 | 66 | 29 | 1,271 | 1,898 |
| Science | 5,267 | 9 | 2,985 | 1,615 | 184 | 18 | 1,529 | 542 |
| Engineering | 23,337 | 56 | 20,214 | 12,850 | 64 | 23 | 2,011 | 969 |
| Agriculture | 3,056 | 7 | 1,835 | 882 | 38 | 17 | 717 | 442 |
| Health | 2,033 | 91 | 1,008 | 802 | 2 | 329 | 398 | 205 |
| Education | 4,167 | 120 | 747 | 83 | 1,430 | 62 | 333 | 1,475 |
| Other | 3,236 | 145 | 1,379 | 493 | 69 | 31 | 584 | 1,028 |
| | | | | **Doctoral** | | | | |
| Total | 9,860 | 1,828 | 2,507 | 922 | 49 | 1,817 | 35 | 3,624 |
| Humanities | 920 | 210 | 108 | 5 | 19 | 2 | 10 | 571 |
| Social science | 650 | 255 | 66 | 6 | 2 | 1 | 6 | 320 |
| Science | 1,145 | 116 | 392 | 108 | 14 | 4 | 5 | 614 |
| Engineering | 2,434 | 447 | 1,245 | 619 | 6 | 1 | 5 | 730 |
| Agriculture | 780 | 123 | 282 | 71 | 4 | 12 | 3 | 356 |
| Health | 3,370 | 530 | 284 | 88 | 0 | 1,796 | 5 | 755 |
| Education | 180 | 70 | 21 | 1 | 0 | 0 | 1 | 88 |
| Other | 381 | 77 | 109 | 24 | 4 | 1 | 0 | 190 |

[a] Manufacturing is a subset of the "total" in industry.

[b] Other includes nonresponses.

**SOURCE:** Monbusho, Basic School Survey.

Under these circumstances, Monbusho's University Council now predicts that enrollment in graduate programs—master's and doctoral degrees combined—will increase from 170,000 in 1997 to 250,000 by 2010. In other words, as shown in table 7, the number of graduates in each year will increase from 60,000 to 93,000 or 94,000. As for supply and demand, demand is predicted to exceed supply for master's degrees, while current policies will lead to a supply exceeding demand for doctorates even in science and engineering. The situation in the humanities and social sciences is projected to be much worse. Thus, an emerging policy issue is how to improve the educational and research quality relevant to actual demand and also improve the environment around graduate education that is now poorly organized. In other words, a crucial point for graduate schools will be whether they can produce master's and doctorate degrees attractive to industry, government, and the business world.

**Table 7. University Council estimates for Japan on supply and demand of master's and doctoral students, 1997-2010**

| | 1997 | 2010 supply | | 2010 demand | |
|---|---|---|---|---|---|
| Field | Actual | High | Low | High | Low |
| | | | **Master's** | | |
| Total | 50,430 | 76,561 | 74,900 | 79,947 | 72,635 |
| Humanities | 3,723 | 5,612 | 5,139 | 4,792 | 4,537 |
| Social science | 5,611 | 10,386 | 9,281 | 8,423 | 7,748 |
| Science | 5,267 | 7,612 | 7,512 | 8,670 | 7,780 |
| Engineering | 23,337 | 33,428 | 33,751 | 40,397 | 36,211 |
| Agriculture | 3,056 | 3,556 | 4,362 | 4,918 | 4,451 |
| Health | 2,033 | 3,218 | 3,158 | 2,826 | 2,640 |
| Education | 4,167 | 6,643 | 6,344 | 5,022 | 4,779 |
| Other | 3,236 | 6,106 | 5,353 | 4,899 | 4,489 |
| | | | **Doctoral** | | |
| Total | 9,860 | 17,974 | 17,878 | 12,931 | 11,957 |
| Humanities | 920 | 1,728 | 1,662 | 1,110 | 1,059 |
| Social science | 650 | 1,570 | 1,406 | 773 | 742 |
| Science | 1,145 | 2,038 | 2,026 | 1,667 | 1,495 |
| Engineering | 2,434 | 4,824 | 4,640 | 3,774 | 3,322 |
| Agriculture | 780 | 1,555 | 1,438 | 1,098 | 998 |
| Health | 3,370 | 4,523 | 5,135 | 3,777 | 3,660 |
| Education | 180 | 467 | 428 | 212 | 204 |
| Other | 381 | 1,269 | 1,143 | 520 | 477 |

**NOTE:** "High" is an estimate from recent 10-year trends; "low" is from recent 15-year trends.

**SOURCE:** University Council of Japan.

## Japanese Educational Reform Programs as of August 1997

### Revitalization of Higher Education Institutes

- **Implementation of university reform.** Responding to the revision of the National Standards for the Establishment of Universities in 1991 and the initiation of a self-monitoring and self-evaluation system, each university now reviews its education and research system, improves its curriculum as well as its method of education, and actively implements the self-monitoring and self-evaluation system. To further promote university reform, each university will improve its evaluation system by listening to the opinions of outside knowledgeable persons and experts, such as academicians, heads of related municipalities, and representatives of local industry. Each university will continuously review and evaluate reforms and try to publicize as much information as possible, including the results of self-evaluations.

- **Promotion of enrichment in graduate schools and reorganization of undergraduate departments.** Monbusho will examine models of higher education that play a leading role in advanced scientific research and that respond to the global demand for capable individuals while meeting the challenges of decreasing college-age population and changing industrial structure. At the same time, Monbusho will promote enrichment of graduate schools and reorganization of undergraduate departments.

  Several reports to the University Council called for reforms in graduate education. These reports included suggestions for "allowing more flexibility in the existing systems of graduate schools" (December 1988), "the improvement and enhancement of graduate schools" (May 1991), and "the quantitative development of graduate schools" (November 1991). Monbusho is using these recommendations to reform the graduate education system. It will also enhance and strengthen graduate schools by establishing postgraduate and nondegree courses for graduates mainly in the field of pioneering and interdisciplinary research.

- **Improvement and enhancement of scholarship loan program.** The scholarship loan program for graduate students will be improved and enhanced to respond to the growing needs for training researchers and specialized professionals.

## Training Promising Talent for the Future Advancement of Science and Technology, and Promotion of Science and Research in Response to Social Needs

- **Promotion of science and technology education to heighten the interest of young students in science and technology.** Monbusho aims to heighten elementary and lower secondary school students' interest in science and deepen their understanding of technology. It will support educational activities in science and technology for young people by utilizing science museums as well as university museums and by holding exhibitions related to science and technology. Moreover, the ministry will seek to increase the attraction of young people to science and technology through the "science volunteer" system, including the teaching staff of universities and colleges of technology as well as industrial researchers. Science museums' educational facilities can use these volunteers to give lectures and/or to carry out experiments for students.

- **Cooperative training among universities, institutes, and industry.** Monbusho is promoting internship programs with industry in which students work professionally in their major area for future career purposes. Monbusho will hold discussions between interested parties, including universities, colleges of technology, and industry, as well as knowledgeable persons and experts in technology.

Enrichment of education and research on venture business at institutions of higher education is aimed at training more capable venture business specialists. Monbusho is looking to attract highly qualified people in business into teaching. It is requesting industry's active cooperation with institutes in the areas of personnel interchange, provision of funds, and provision of information on markets and technology.

- **Enhancement of human resources in the science and engineering field.** Monbusho has promised to carry out the reorganization of departments and courses in science and engineering fields, and to promote modernization of educational facilities for laboratory work to enhance innovation in Japanese science and technology in the future. Furthermore, it seeks to support creative education programs that consist of various activities to cultivate students' creativity at universities and colleges of technology, and will disseminate best practices in developing creative human resources.

- **Personnel training and improvement of research environment in response to social needs.** Monbusho has promoted and initiated a 10,000 Postdoctoral Fellowships Program to support innovative young researchers. This will provide for the funding of research assistants within universities and national laboratories. At the same time, it is attempting to create better research environments by improving facilities and equipment. Further, it will allow cooperative relationships with other related ministries and agencies for the joint funding of research projects.

- **Enhancement of competitive funds.** Competitive funds will be enriched to promote inventive and innovative research in institutes. To make the funds distribution process more selective and efficient, Monbusho will promote implementation of prior, midterm, and posterior evaluations by outside organizations; disclosure of evaluation results- and reflection of evaluations on the distribution of funds.

**SOURCE:** Monbusho.

## The Impact of Financing and Sources of Support for Graduate Education on Time to Degree

There are no official statistical data concerning the relation of financing for graduate students to their time to degree in Japan. However, a 1993 survey showed that the biggest reason why students did not continue their doctoral studies was because they had financial problems (Yamamoto 1996).

Regarding time to degree in Japan, there is great diversity by field. There are very few degrees granted compared to enrollment in the humanities and social sciences, while the success rate of degree completions is much higher in the fields of science, engineering, and medicine. In science and engineering, the ratio of doctoral degree granting is reasonably high; the ratio is far lower in the humanities and social sciences (table 9).

This fact reflects the differences in degree granting standards by field—i.e., whether the doctoral degree is a license for researchers or a prize for accomplished researchers in a particular field. Different modes of training may also affect the rate of degree granting. In science and engineering, the laboratory-intensive apprentice mode allows for easier communication between students and mentors, while the latter case is more difficult under the library-intensive individualistic research mode (Gumport 1993).

## Distribution of Doctoral Degrees Within Countries and Abroad, and Foreign Doctoral Recipients

Monbusho conducts no official survey regarding the number of doctoral degrees granted to Japanese students who study abroad. However, the National Science Foundation's (NSF's) survey on U.S. universities' doctoral grants to foreign students sheds some light on this matter. According to an NSF analysis, "Compared to major Asian countries of origin, the number of students from Japan earning doctoral degrees in the United States is relatively small. Japanese industries often finance advanced training of their employees in U.S. universities for

| Table 8. Sources of financial support for graduate students in Japan, according to a 1993 survey (percentages) | | | | | | | |
|---|---|---|---|---|---|---|---|
| Field | Parent/ spouse | Self-support | JSF's loan | Other scholarship | JSPS fellowship[a] | TA/Ra[a] | Other |
| | Master's | | | | | | |
| Total | 56 | 11.6 | 23.8 | 7.5 | | 0.4 | 0.6 |
| Humanities | 46.1 | 19.4 | 26.1 | 6 | | 1.2 | 1.2 |
| Social science | 46 | 20 | 27 | 6 | | 0.5 | 0.5 |
| Science | 55.8 | 5.4 | 30.6 | 7.5 | | 0.7 | 0 |
| Engineering | 58.7 | 10.4 | 21.7 | 8.1 | | 0.2 | 0.8 |
| Agriculture | 59.5 | 9.9 | 22.9 | 6.8 | | 0.8 | 0 |
| Health | 57 | 5.6 | 28 | 9.4 | | 0 | 0 |
| Education | 68.8 | 12.5 | 12.5 | 6.3 | | 0 | 0 |
| Other | 56 | 13.6 | 27.3 | 2.3 | | 0 | 0 |
| | Doctoral | | | | | | |
| Total | 25.2 | 19.4 | 44.3 | 4.3 | 4.9 | 0.4 | 1.5 |
| Humanities | 26.3 | 33.8 | 33.8 | 2.5 | 2.5 | 0 | 1.3 |
| Social science | 22.5 | 28.2 | 40.8 | 1.4 | 4.2 | 1.4 | 1.4 |
| Science | 16.9 | 10.2 | 54.2 | 6.8 | 11.9 | 0 | 0 |
| Engineering | 25 | 14.2 | 44.6 | 8.2 | 4.7 | 0.7 | 2.7 |
| Agriculture | 29.7 | 13.5 | 56.8 | 0 | 0 | 0 | 0 |
| Health | 36 | 12 | 48 | 0 | 4 | 0 | 0 |
| Education | 10 | 40 | 50 | 0 | 0 | 0 | 0 |
| Other | 34.3 | 11.4 | 40 | 2.9 | 8.6 | 0 | 2.9 |

[a] Since JSPS fellowships and teaching assistantships/research assistantships were not fully implemented in 1993, answers for these columns are incomplete.

**NOTE:** Data were compiled from responses to the question, "What is your primary source of support?"

**SOURCE:** Yamamoto, S. Graduate Schools in Japan From the Perspective of Academic Research. *University Studies* 15:1-287, (1996).

| Table 9. Doctorate granting ratio in Japan | | | |
|---|---|---|---|
| | 1990 | 1995 | 1995-90 |
| Field | Percent | | (Ratio) |
| Total | 63.4 | 67.4 | 1.1 |
| Humanities | 3.2 | 14.0 | 4.4 |
| Social science | 13.1 | 21.4 | 1.6 |
| Science | 65.1 | 68.9 | 1.1 |
| Engineering | 70.9 | 79.9 | 1.1 |
| Agriculture | 68.1 | 69.5 | 1.0 |
| Health | 85.2 | 85.0 | 1.0 |
| Education | 12.4 | 15.0 | 1.2 |

**NOTE:** The doctorate granting figures are obtained by dividing the number of doctorates granted by the number of entrants into doctoral programs 5 years before (for health, 4 years before).

**SOURCE:** The Monbusho Survey of Education.

1 to 2 years, but relatively few remain long enough to complete a doctoral program" (NSB 1998). This means that there are relatively few Japanese who obtain doctoral degrees in science and engineering at U.S. universities.

In addition, the author's sample survey of the faculty of Tsukuba University (table 10) shows that there are a substantial number who received degrees from foreign universities in the humanities and social sciences. In science and engineering, according to the NSF analysis, there are very few faculty members who earned their Ph.D.s at foreign universities. This contrast between the humanities and social sciences on the one hand, and science and engineering on the other, is a reflection of the fact that Japanese universities have tended to decline in the number of doctoral degrees in the humanities and social sciences granted to those who studied in doctoral programs in Japan. As mentioned earlier, it is not easy to change the national attitude toward doctorates in the humanities and social sciences, where a doctorate is perceived more as an award for an established scholar than a license for further research.

## Patterns of International Mobility

The numbers of Japanese students who study abroad and foreign students who study at Japanese universities are shown in tables 11 and 12. Note that the Japanese students' figures do not exactly reflect the situation of study abroad because they were obtained from emigration data asking about the purpose of travel.

| Table 10. Doctoral degrees of the University of Tsukuba's faculty granted by Japanese and foreign universities (sample survey) | | | | | | |
|---|---|---|---|---|---|---|
| Field | No doctorate | | Granted by Japanese universities | | Granted by foreign universities | |
| | Professor | Associate professor or below | Professor | Associate professor or below | Professor | Associate professor or below |
| Humanities total | 40 | 84 | 28 | 14 | 10 | 17 |
| Philosophy | 5 | 5 | 4 | 2 | 1 | 2 |
| History | 6 | 18 | 16 | 6 | 2 | 5 |
| Literature | 15 | 29 | 5 | 4 | 4 | 4 |
| Language | 14 | 32 | 3 | 2 | 3 | 6 |
| Social science total | 22 | 26 | 33 | 35 | 21 | 20 |
| Social sciences | 19 | 19 | 10 | 12 | 3 | 4 |
| Political sciences | 3 | 7 | 23 | 23 | 18 | 16 |
| Natural sciences total | 0 | 5 | 73 | 176 | 3 | 5 |
| Biology | 0 | 0 | 17 | 37 | 1 | 0 |
| Mathematics | 0 | 3 | 15 | 28 | 0 | 0 |
| Physics | 0 | 0 | 19 | 53 | 0 | 2 |
| Chemistry | 0 | 1 | 9 | 26 | 1 | 1 |
| Geosciences | 0 | 1 | 13 | 32 | 1 | 2 |
| Engineering total | 0 | 4 | 70 | 127 | 7 | 9 |
| Applied physics | 0 | 0 | 16 | 33 | 4 | 3 |
| Material science | 0 | 0 | 16 | 31 | 0 | 0 |
| Engineering mechanics | 0 | 2 | 16 | 26 | 1 | 1 |
| Electrical engineering | 0 | 2 | 22 | 37 | 2 | 5 |

**SURVEY:** Survey of University of Tsukuba's faculty by Yamamoto.

Since the mid-1980s, Monbusho has been implementing the 100,000 Foreign Students Plan, which aims to increase the number of students from abroad to 100,000 by the year 2001. This goal assumes the acceptance of 30,000 students at the graduate school level. As of May 1997, about 20,000 foreign students were studying at graduate schools in Japan, while 32,000 were studying in undergraduate programs. The attainment of 100,000 students by the beginning of the 21st century now seems unrealistic due to the economic recession in Japan and other Asian countries. However, Monbusho thinks it is important to improve admission systems for foreign students, especially at the graduate level, from the viewpoint of promoting international exchanges in education as part of Japan's efforts to make an international contribution appropriate to its rising international status.

| Table 11. Number of Japanese students studying abroad, 1990 and 1995 | | |
|---|---|---|
| Country | 1990 | 1995 |
| Total | 29,216 | 59,468 |
| Australia | 218 | 675 |
| Austria | 196 | 251 |
| Canada | 312 | 774 |
| China | 806 | 8,526 |
| France | 863 | 1,157 |
| Germany | 1,200 | 1,236 |
| South Korea | 562 | 392 |
| U.K. | 657 | 2,042 |
| United States | 24,000 | 43,770 |
| Other | 402 | 645 |

**SOURCE:** The Monbusho Survey of Education (from data of the Ministry of Justice).

Education and research guidance for foreign students must reflect those students' needs. Some universities are actively facilitating the admission of foreign students through measures that include the expansion of Japanese language education programs, the introduction of

| Table 12. Number of foreign students studying at Japanese universities and colleges, 1960-97 | | | | |
|---|---|---|---|---|
| Year | Total | Under-graduate | Graduate | Junior colleges |
| 1960 | 4,703 | 3,874 | 557 | 272 |
| 1970 | 10,471 | 7,730 | 1,857 | 884 |
| 1980 | 15,008 | 10,913 | 2,644 | 1,451 |
| 1990 | 38,444 | 23,571 | 12,306 | 2,567 |
| 1997 | 55,114 | 32,432 | 20,051 | 2,631 |

**SOURCE:** The Monbusho Survey of Education.

instruction in foreign languages, and provision for theses written in foreign languages. Efforts are also being made to improve education and research guidance systems in graduate departments to which large numbers of foreign students have been admitted. Measures in this area include the appointment of more teaching staff to research programs.

# Current Situation of Korean Graduate Education and Its Reform

## Higher Education and the Granting of Degrees

There are numerous similarities in the school systems of Japan and the Republic of Korea. In both countries, a linear school system of the 6-3-3-4 type has been adopted. This means Korea has a school system with 6 years of elementary school, 3 years of middle school, 3 years of high school, and 4 years of university or college. Every citizen who finishes upper secondary school (high school) is eligible to apply for admission to institutes of higher education. Institutes of higher education in the Republic of Korea are classified into four categories: (1) colleges and universities offering 4-year undergraduate programs (medical and dental colleges, 6 years); (2) 2- to 3-year junior colleges; (3) universities of education; and (4) miscellaneous schools.

Among those higher education institutions, 4-year colleges and universities may have graduate schools. Enrollment in graduate schools is shown in Table 13. These are classified into three types in accordance with their functions and goals: professional graduate schools, general graduate schools, and open graduate schools. This situation differs from Japanese graduate education, which has no formal classifications and in which academic research and professional training are not separated within a single system.

Professional graduate schools prepare students for professional careers in education, business administration, public administration, and other fields. The academic degree that the professional graduate schools confer is a professional master's degree. General graduate schools aim to foster creativity, initiative, and leadership in specialized academic disciplines. General graduate schools award a master of arts or master of science to those who complete the graduation requirements. Students in doctoral programs at general graduate schools must have a master's degree or equivalent, a scholarly background in their field of specialization with some demonstrated research experience, and recommendations from individuals in their field of specialization. Doctoral degrees are shown in Table 14.

## Development and Reform of Higher Education

The current higher education system was introduced after the establishment of the Republic of Korea in 1948

| Table 13. Enrollment in Korean graduate schools, as of 1997 | | | | | |
|---|---|---|---|---|---|
| Field | Grand total | Master's degree course | | | Doctoral course |
| | | Total | General | Professional | |
| Total | 151,358 | 128,097 | 60,634 | 67,463 | 23,261 |
| Humanities | 15,323 | 12,669 | 6,454 | 6,215 | 2,654 |
| Social sciences | 36,251 | 32,639 | 9,674 | 22,965 | 3,612 |
| Natural sciences | 50,802 | 39,778 | 29,377 | 10,401 | 11,024 |
| Medical and pharmacy | 13,010 | 8,512 | 7,022 | 1,490 | 4,498 |
| Arts and physical education | 8,502 | 8,021 | 4,907 | 3,114 | 481 |
| Teaching profession | 27,470 | 26,478 | 3,200 | 23,278 | 992 |

**SOURCE:** Korean Ministry of Education, *Statistical Yearbook of Education* (Seoul, 1998).

**Table 14. Granting of doctoral degrees at Korean universities, March 1996 to February 1997**

| | |
|---|---|
| Total | 2,713 |
| Humanities | 700 |
| Social sciences | 649 |
| Natural sciences | 2,444[a] |
| Medical and pharmacy | 1,120 |
| Arts and physical education | 100 |
| Teaching profession | 144 |

[a] Doctorates in engineering total 1,420 and are included with natural sciences.

**SOURCE:** Korean Ministry of Education, *Statistical Yearbook of Education,* Seoul, 1998.

under the strong influence of the American system. After going through hard times, the Korean higher education system experienced a large quantitative expansion in the 1960s and 1970s owing to remarkable economic progress. Following a rapid expansion as in Japan, Korean education endeavored to emphasize and enhance the quality of education, and the Fifth Republic clearly established in the constitution the institutionalization of life-long education. In addition, the republic set as one of the nation's top priorities the formation of a sound personality through education and reform of civil education, emphasizing science and life-long education.

In March 1985, the Presidential Commission on Educational Reform was established under the direct supervision of the president.[4] To achieve the goal, set forth in a 1992-96 plan, of Educating Koreans as the Prospective Leaders for the 21st Century, the commission carried out extensive studies through December 1987 and recommended various kinds of reform measures, including reform of the school system, development of high-level manpower in science and technology, and a drastic increase in educational investment. The recommendations were adopted and enacted consecutively; later, in May 1988, the Advisory Council for Educational Policy was inaugurated as an advisory council to the minister of Education.

The 1990s have witnessed advances in education through the realization of quality education and educational welfare. A particular concern is the pursuit of qualitative, rather than quantitative, growth. The above-referenced plan of Educating Koreans as the Prospective Leaders for the 21st Century exemplifies the goals of Korean education.

In response to the growing importance of science and technology, the Ministry of Education recently initiated a discussion on the further reform of the graduate education system in Korea, which aims at further supporting leading graduate schools by a reallocation of resources.

## Foreign Students in Korea and Korean Students in Foreign Countries

The number of international students attending higher educational institutes in Korea has increased steadily in recent years. As of June 30, 1996, the total stood at 2,143. (see Table 15.) By type of educational institution, about 40 percent of these foreign students attended graduate schools at universities; the rest attended undergraduate and other courses.

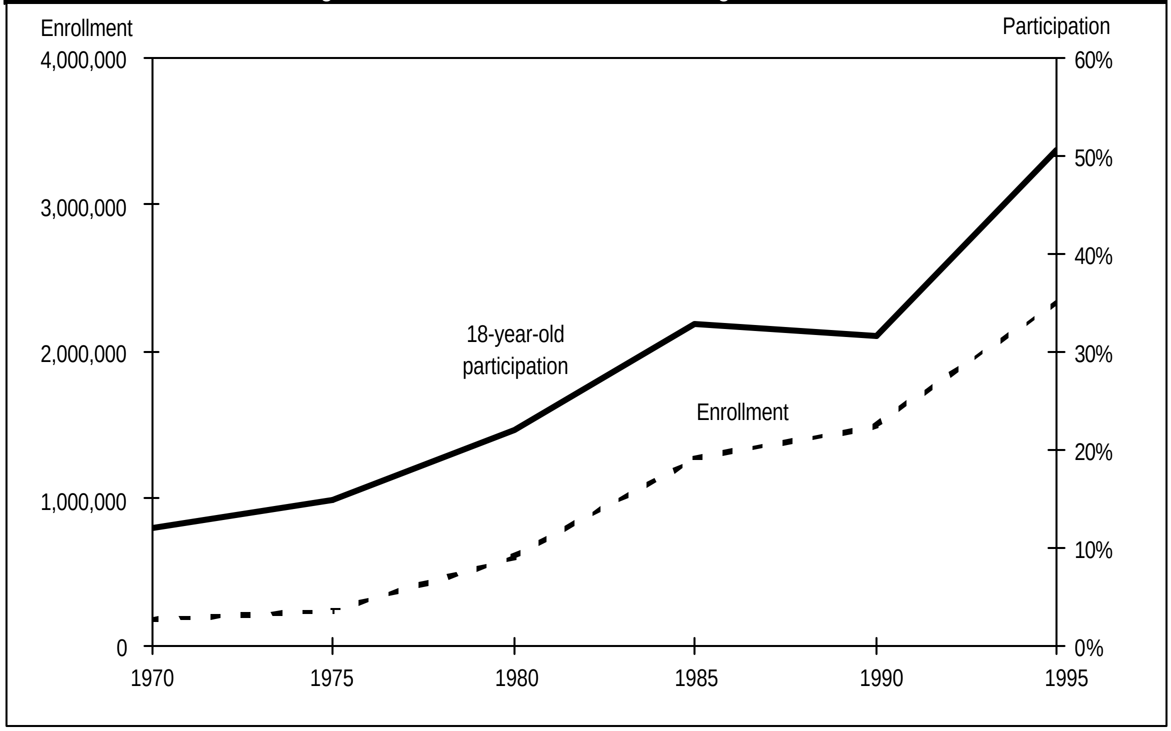
One of the features of doctorate granting for Koreans is that a relatively high percentage is granted Ph.D.s by foreign universities. For example, there were 1,004 Koreans who obtained doctorates in science and engineering at U.S. universities in 1995, compared to 2,444 science and engineering doctorates awarded by Korean universities in the following year (see table 14 and NSB 1998). This is a great contrast to Japan's situation, where 4,540 doctorates were awarded at Japanese universities in 1995, while only 154 Japanese obtained doctorates in science and engineering at U.S. universities that same year (see table 1 and NSB 1998). Table 16 indicates similar degree-earning tendencies regarding Korean university faculties, although the data are not very recent.

## Conclusion

Japan and Korea are now making efforts to adjust their graduate education systems to global levels and quality standards, under the pressures of the ongoing massification of higher education and of international competition in scientific research. Both countries have confronted the growing impact of Western culture and civilization since the latter part of the 19th century and have tried to establish their own higher education and scientific research systems. The establishment of the Imperial University at Tokyo in 1886 was one of Japan's strong responses.

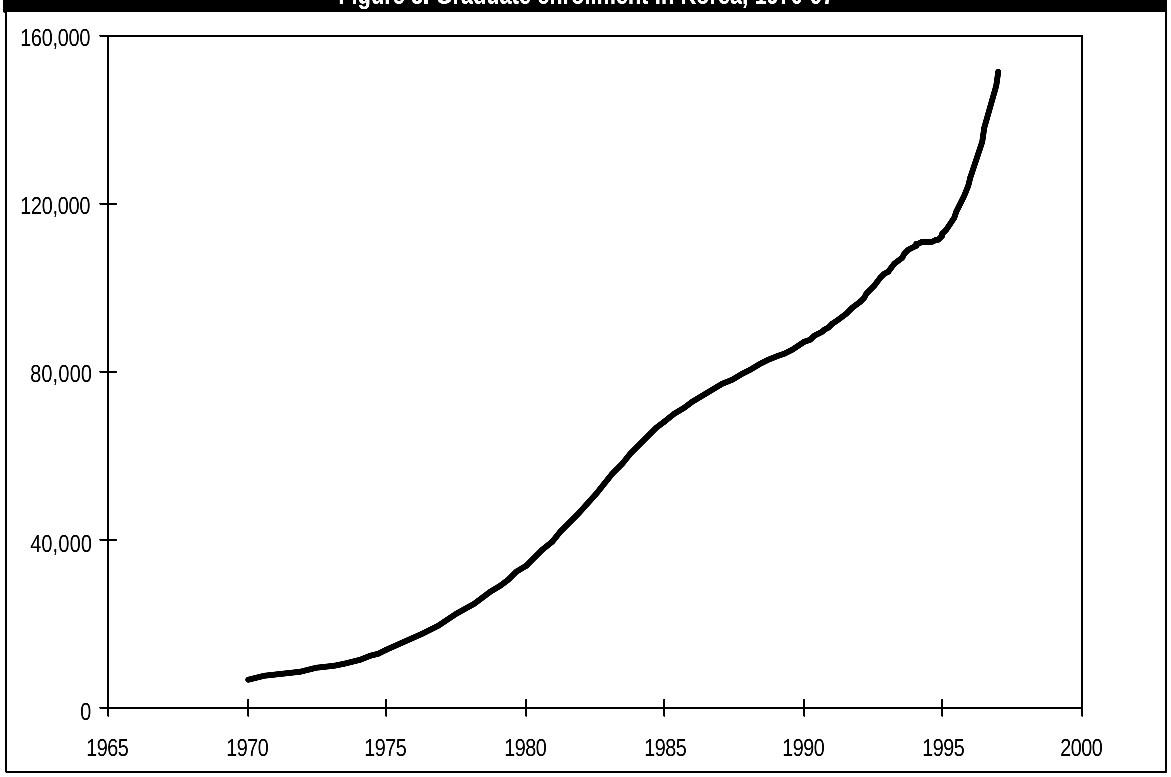
[4] Incidentally, Japan also established a National Council on Educational Reform during the same period (1984-87) under the strong initiative of Prime Minister Nakasone; the recommendations of the council still have a strong influence on current educational reform in Japan.

**Figure 4. The massification of Korean higher education**




**SOURCE:** Korean Ministry of Education, *Statistical Yearbook of Education.* Annual Series.

**Figure 5. Graduate enrollment in Korea, 1970-97**




**SOURCE:** Korean Ministry of Education, *Statistical Yearbook of Education.* Annual Series.

| Table 15. Foreign students at Korean universities | | | | |
|---|---|---|---|---|
| Nationality | Total | Undergraduate | Graduate | Others |
| Total | 2,143 | 1,279 | 803 | 61 |
| Argentina | 49 | 44 | 4 | 1 |
| Canada | 58 | 27 | 31 | 0 |
| China | 486 | 181 | 291 | 14 |
| Germany | 14 | 9 | 5 | 0 |
| Japan | 395 | 242 | 149 | 4 |
| Malaysia | 130 | 99 | 1 | 30 |
| Paraguay | 28 | 27 | 1 | 0 |
| Taiwan | 444 | 398 | 37 | 9 |
| United States | 299 | 130 | 169 | 0 |
| Others | 240 | 122 | 115 | 3 |

**SOURCE:** Korean Ministry of Education, *Statistical Yearbook of Education* (Seoul, 1998).

| Table 16. Origins of university faculty doctorates by country and field, 1983 (percentages) | | | | | |
|---|---|---|---|---|---|
| Field | Korea | North America | Europe | Asia | Others |
| Total | 61.1 | 21.9 | 8.7 | 8.0 | 0.3 |
| Humanities | 39.2 | 38.3 | 15.7 | 6.5 | 0.3 |
| Social sciences | 47.2 | 36.4 | 11.6 | 4.7 | 0.2 |
| Science | 53.5 | 29.7 | 6.0 | 9.4 | 0.4 |
| Engineering | 56.8 | 19.1 | 10.3 | 13.6 | 0.2 |
| Linguistics | 60.1 | 14.1 | 18.9 | 6.6 | 0.1 |
| Business administration | 65.5 | 26.1 | 5.4 | 3.0 | 0.0 |
| Arts and physical education | 24.6 | 60.7 | 11.5 | 3.3 | 0.0 |
| Fishery | 53.0 | 6.1 | 19.7 | 21.2 | 0.0 |
| Medicine | 90.2 | 3.7 | 1.6 | 4.4 | 0.1 |
| Agriculture | 63.4 | 14.7 | 3.9 | 17.1 | 0.9 |

**SOURCE:** Lee, S.H., "The Emergence of Modern Univeristies in Korea," in P.G. Altbach, ed., From Dependence to Autonomy: The Development of Asian Universities, pp. 312-47 (1993).

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# Graduate Education Reforms and International Mobility of Scientists and Engineers in Taiwan

*Yugui Guo*

## Historical Review

Taiwan, an island off the southeast of mainland China, is one of the most densely populated areas in the world: 35,873 square kilometers in size with more than 21 million inhabitants. Taiwan was part of China before it was ceded to Japan in 1895. During the 50 years of Japanese occupation, a Western-style system of education was first introduced into Taiwan via the Japanese (Chen 1997). One university, one high school, and three junior colleges were established during that time. The enrollment was very small, and the function of these institutions was to provide a research capability and high-level manpower in support of Japan's policies of colonization and expansion.

At the end of World War II in 1945, Taiwan was restored to China. The island's educational system was soon replaced by the one adopted on the mainland since 1922, which mainly follows the American prototype (Chen 1997). After the Chinese National Party moved its seat to Taiwan in 1949, Chinese educational policy was imposed on the island more thoroughly than before and Japanese influence diminished further.

Since then, Taiwan has developed rapidly. To meet the needs of immediate economic development and the growing demand for skilled human resources, higher education expanded rapidly between the 1950s and 1980s. Tables 1 and 2 show that, during this interval, the number of tertiary institutions increased by a factor of 15 (from 7 in 1950-51 to 107 in 1987-88), while enrollment swelled 54 times (from 6,665 in 1950-51 to 362,001 in 1987-88). Graduate enrollment increased from almost nothing in 1950-51 to 15,121—including 12,426 master's degree students and 2,695 doctoral students—in the 1987-88 academic year. This rapid expansion in higher and graduate education was driven by many forces, including the development of secondary education; the needs of a growing college-age population for higher and advanced education; and, most important, the takeoff of the economy since the 1970s. This last gave a great impetus to higher and graduate education in Taiwan.

**Table 1. Number of tertiary institutions in Taiwan (1950-88)**

| Academic year | Type of Institution | | Total |
|---|---|---|---|
| | Universities and colleges | Junior colleges | |
| 1950-51 | 4 | 3 | 7 |
| 1960-61 | 15 | 12 | 27 |
| 1970-71 | 22 | 70 | 92 |
| 1980-81 | 26 | 77 | 103 |
| 1987-88 | 39 | 68 | 107 |

**SOURCES:** Ministry of Education, *Educational Statistics of the Republic of China,* 1997, pp. 2-5. Shun-fen Chen, "Taiwan," in Philip G. Altbach, Editor, *International Higher Education: An Encyclopedia* (Garland Publishing, Inc., 1991), pp. 550-51.

**Table 2. Enrollment at tertiary institutions in Taiwan (1950-88)**

| Academic year | Master's | Doctorate | Undergraduate | Junior college[a] | Total |
|---|---|---|---|---|---|
| 1950-51 | 5 | | 5,374 | 1,286 | 6,665 |
| 1960-61 | 426 | 11 | 26,737 | 7,888 | 35,060 |
| 1970-71 | 2,129 | 166 | 92,850 | 55,301 | 150,446 |
| 1980-81 | 5,633 | 673 | 153,088 | 105,246 | 264,640 |
| 1987-88 | 12,426 | 2,695 | 192,933 | 153,947 | 362,001 |

[a] First-, second-, and third-year students at 5-year junior colleges are excluded.

**SOURCES:** Ministry of Education, *Educational Statistics of the ROC*, 1997, pp. 2-5. Shun-fen Chen, "Taiwan," in Philip G. Altbach, Editor, *International Higher Education: An Encyclopedia* (Garland Publishing, Inc., 1991), pp. 550-51.

## Current System

Higher and graduate education in Taiwan have witnessed a remarkable development since the mid-1980s. This development has been coupled with a series of political, economic, and social reforms that emerged with and were affected by changes in domestic and international contexts.

Higher education in Taiwan is offered by three types of institutions: (1) junior colleges, (2) independent colleges, and (3) universities. By 1997, there were a total of 67 junior colleges, 44 independent colleges, and 26 universities. Junior colleges provide 2- to 3-year programs leading to a diploma (similar to the American associate degree in terms of academic standards). Those with only one or two schools are called independent colleges. Universities consist of at least three colleges (or schools). Both independent colleges and universities offer 4-year programs leading to a bachelor's degree. Many of them also offer master's-level programs, and some offer doctoral-level programs, depending on the academic performance of the department concerned. In the 1996-97 academic year, 67 independent colleges and universities offered bachelor's-level training. There were 536 master's programs and 116 doctoral programs in these universities and independent colleges. Four-year undergraduate enrollment has increased by 75 percent over the past 9 years (from 192,933 to 337,837), while enrollment in master's and doctoral degree programs has risen to 35,508 and 9,365—2.6 times and 3.5 times the figures for the 1987-88 academic year, respectively.

One of the characteristics of the Taiwan higher education system is that there are more private institutions than public ones. In 1997, out of 137 colleges and universities, 51 are public and 86 are private (Li 1997). However, of 24 universities, 16 are public and 8 are private; out of 43 independent colleges, 21 are public and 22 are private (Ministry of Education 1997). The universities are all comprehensive in nature, while the independent colleges generally focus on specific disciplines such as fine arts, medicine, technology, and teacher training. Among the 4-year institutions, public institutions are preferred over private by most students because the faculty qualifications of the former are usually better. In addition, tuition rates in the public sector are one-third those in the private sector. For example, in the 1996-97 academic year, the public institutions enrolled 25,423 master's degree students and 8,288 doctoral degree students, while the private sector institutions enrolled 10,084 master's degree students and 1,077 doctoral degree students. Recently, the Ministry of Education proposed that private universities with limited resources concentrate their efforts on the teaching of undergraduate students. This can be interpreted as a governmental intention to develop a policy of stratification, with public institutions emphasizing both graduate programs and research activities, and private institutions emphasizing undergraduate teaching.

## Governance and Finance

According to the constitution of Taiwan, the state has the power to supervise educational institutions at all levels. Thus, higher education in Taiwan has for a long time been marked by strong centralization. The institutions of higher learning are regulated with little flexibility. Almost every policy regarding higher education is made by the central government.

The Ministry of Education not only approves the establishment of new institutions, departments, and programs, but also controls the size of enrollment, tuition rates, required courses, minimum graduation credits, and other factors at all institutions, both public and private. Presidents of public institutions are chosen and appointed by the Ministry of Education. Those of private ones are appointed by their board of trustees with the approval of the Ministry of Education. As most of Taiwan's university presidents are closely connected with the ruling party, and many of them were former government officials, the government's control of the presidency often results in a degree of politicization on campus.

All public colleges and universities receive government funding. Public institutions receive their annual budgets from the government with specific amounts for each budget category, and tuition collected from students must be returned to the government. For private institutions, the major source of income is tuition. Government subsidies to them are limited, usually up to 15 to 20 percent depending on the efficiency of education and overall accreditation each year. In 1997, the total expenditure of government on education reached US$15.3 billion, more than 5 percent of the gross national product (GNP).

The reason that all public schools are entitled to full support derives from the constitution. Article 164 of Taiwan's constitution states: "Expenditures of educational programs, scientific researches and cultural services shall not be, in respect of the Central Government, less than 15 percent of the total national budget; in respect of each province, less than 25 percent of the total provincial budgets, and 35 percent in the level of municipality or county" (Li 1997). This provision financially and legally guarantees the development of higher education.

The centralized character of the higher education system has been widely criticized; beginning with the political reforms of 1986—especially since the lifting of martial law in 1987—Taiwan's higher education system has gradually been transformed. The promulgation of the newly revised University Act in early 1994 further laid a legal foundation for decentralization and depoliticization. According to this new act, the relationship between the government and universities has been changed, with more autonomy granted to universities. The three major reforms are as follows (Li 1997):

- **University autonomy.** Under the newly implemented educational reform policy, the main function of the Ministry of Education is to "oversee" and "guide" universities instead of "governing" them, and all public universities have been granted the right of self-governance. Specifically, university presidents will no longer be appointed by the Ministry of Education, but selected either by a search committee or by votes from all faculty members in the university. However, the University Act still specifies that the Ministry of Education holds final power over the appointment of presidents of national universities (Law 1995). Deans, chairpersons, and new faculty members to be employed are also determined by the faculty. Original core courses are no longer mandatory, depending on the decision of the curriculum committee of the faculty senate of the university.

- **Diversifying budgets.** The Ministry of Education will no longer allocate the complete budget to each public university. Instead, support will be limited to an allocation of a ceiling of up to 80 percent of the total overall budget requested for a given fiscal year. Each institution must undertake efforts to raise funds and find resources from the society at large, rather than being solely dependent on the government.

- **Transfer of credits.** A new policy on the transfer of credits has also been approved under the current reform campaign. Students do not have to restrict themselves to a single university, but are now allowed to take courses at other universities, if time permits. They are even allowed to transfer credits earned overseas during summer programs on the condition that the corresponding university is an accredited institution of higher learning.

These reforms have reflected the trends of decentralization, democratization, and internationalization of higher education in Taiwan in the past several years. As a result, the higher education system is becoming decentralized to a large extent, although all institutions still receive budgets from the Ministry of Education. As the budget of a public institution is to come from diversified sources, there will be a greater chance for institutional autonomy. Allowing students to travel overseas to take a few courses as part of their university studies will broaden their international perspective and better enable them to fulfill their educational goals.

## Degree Structure and Graduate Training

The degree structure and model of graduate training in Taiwan were introduced from the United States. The levels of academic degrees are connected with the different phases of Taiwan's higher education. The academic degrees are divided into three categories: bachelor's degree, master's degree, and doctorate degree (Ministry of Education 1995 and 1997).

### Bachelor's Degree

After taking the highly competitive Joint Entrance Examination set each year by a board composed of university presidents, successful high school graduates are assigned to a university based on their preference and examination results. Once they are admitted to universities, they have to take 128 credits over 4 years, which is the minimum requirement for completion of a bachelor's degree. Though course content generally tends to be closely focused on a student's major subject, there is a current trend toward a wider choice of electives. The bachelor of medicine degree requires 7 years, the bachelor of dentistry 6. Some law and architecture departments require 5 years.

### Master's Degree

Master's degree programs admit university/college graduates, including 3-year junior graduates with 2 years of job experience and 2-year and 5-year junior graduates with 3 years of job experience, to receive education for 2 to 4 years. For the master's degree, 24 credits and a thesis are generally the minimum requirements, followed by a written examination and an oral defense. A minimum residence of 2 years is required.

## Doctorate Degree

The doctoral degree programs admit those having a master's degree and university/college graduates majoring in medicine who have received professional medical training for a minimum of 2 years. At least 18 credits and a dissertation are the minimum requirements, together with a written examination and an oral defense. The doctoral degree usually takes 4 to 6 years to complete. To achieve the goal of life-long education, many universities and graduate institutes create advanced education opportunities by offering various in-service training programs.

The current degree structure and graduate training are undergoing two important changes. The Ministry of Education is planning to establish an associate degree for graduates of junior colleges and to create master's degree programs for in-service employees in 1999 (Cultural Division of Taipei 1998, pp. 24 and 28). These reforms will encourage more people to pursue college studies and increase enrollments in both junior colleges and master's degree programs.

In Taiwan, students wishing to enter a doctoral degree program must pass an entrance examination conducted by the university. Since 1990, a special program has also been available through which students in master's degree programs may apply for direct admission to the doctoral program in their respective institute. They must have earned a grade point average of 85 or higher for their first year of study,[1] be ranked in the top one-third of their class, and have shown a strong capacity for independent research. In addition to the regular full-time students, some qualified students from government and industry are enrolled in doctoral programs through on-the-job training programs sponsored by their respective employers. Most of them are part-time students. Like the regular full-time students, they must pass the entrance examination to become eligible for enrollment in the graduate programs and must successfully complete the graduate program requirements to earn the degree.

To become formal candidates for the doctoral degree, graduate students must pass a qualifying examination. In most universities, students who do not pass the qualifying examination within 2 or 3 years after entering a doctoral program are dismissed from the university. In addition to their coursework, graduate students are also involved in research projects sponsored by the National Science Council, other government entities, or industry. These research projects are carried out under the supervision of advisors, and usually serve as an exploratory or feasibility study that sometimes is a potential framework for the students' doctoral dissertations.

For each doctoral enrollment, the Ministry of Education subsidizes about US$150 for operating expenditures and US$1,200 for expenditures on books, equipment, and facilities; these go directly to the institution. Thus, graduate students only pay part of their overall educational cost by meeting the tuition and miscellaneous fees, which amount to about US$550 per semester. Furthermore, all full-time doctoral students receive a monthly stipend of about US$300, and the top 10 percent are awarded a scholarship of US$550 for the first 3 years, which is provided by the Ministry of Education (Chang and Hsieh 1997). The doctoral degree awarded by universities in Taiwan is a research degree certifying that the recipient has the capability and training needed to engage in independent scholarly work.

## Expansion of Graduate Education

Graduate education in Taiwan has witnessed a rapid expansion in the past 20 years. Table 3 and figure 1 indicate that, from 1975-96, total enrollment increased 10 times while enrollments of master's students and doctoral students increased 9 times and 30 times, respectively. This striking development has been attributed to various factors, including rapid economic and scientific growth, universal secondary education, growing demand of college-age cohort for higher education, and other factors. However, the most important driving force is the political reform that occurred in 1987, which resulted in a quite remarkable growth in graduate enrollment over the next 9 years. In 1996, 35,508 master's students—2.5 times as many as in 1988 (14,119)—were enrolled; doctoral en-

[1]The grading scale is from 0 to 100 at all levels. Many universities and colleges use the following scale on their English transcripts: 85-100 = A, 70-84 = B, and 60-69 = C. The minimum passing score is 60 for undergraduate students and 70 for graduate students.

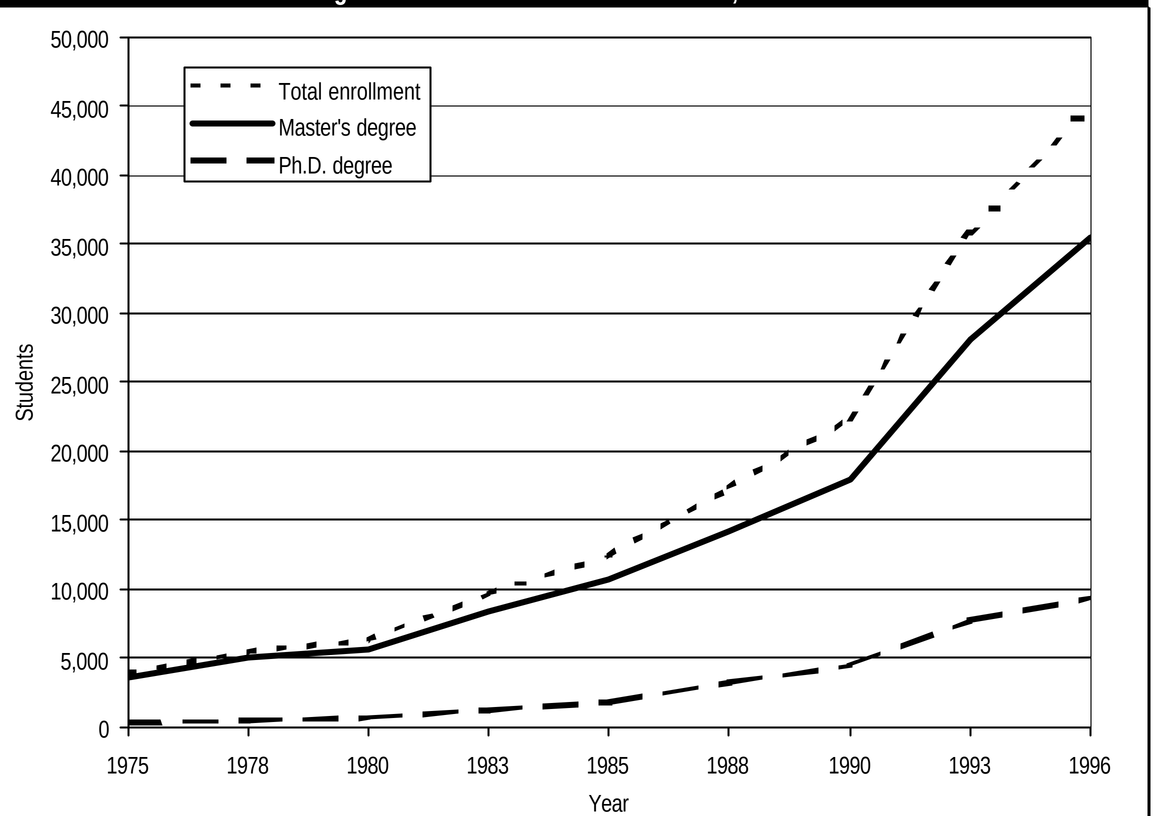
rollment had almost tripled during the same period, rising from 3,222 to 9,365. Since doctoral enrollment showed even faster development, its proportion increased in the degree structure. Before 1988, the enrollment ratio of master's to doctoral students was always more than 10 to 1. After 1988, the situation changed: in 1996, the ratio was only 3.5:1.

**Table 3. Graduate enrollment in Taiwan, 1975-96**

| Year | 1975 | 1978 | 1980 | 1983 | 1985 | 1988 | 1990 | 1993 | 1996 |
|---|---|---|---|---|---|---|---|---|---|
| Total enrollment........................ | 3,912 | 5,442 | 6,306 | 9,647 | 12,418 | 17,341 | 22,372 | 35,830 | 44,873 |
| Master's students.................. | 3,614 | 4,974 | 5,633 | 8,427 | 10,638 | 14,119 | 17,935 | 28,117 | 35,508 |
| Ph.D. students...................... | 298 | 469 | 673 | 1,220 | 1,780 | 3,222 | 4,437 | 7,713 | 9,365 |

**SOURCE:** Ministry of Education, *Educational Statistics of the Republic of China,* 1997, pp. 20-21.

**Figure 1. Graduate enrollment in Taiwan, 1975-96**




**SOURCE:** Ministry of Education, *Educational Statistics of the Republic of China,* 1997, pp 20-21.

## Home- and U.S.-Awarded Doctoral Degrees

As in most other developing and newly industrializing economies (NIEs), graduate education in Taiwan, especially doctoral training, has been lagging behind the economy in terms of its rate and level of development. Graduate education needs a heavier investment than education at any other level. In addition to financial support, a higher development level of science and technology (S&T) is necessary to ensure the quality and standards of graduate education. Graduate education is closely linked with and conditioned by the development of the national economy. For example, before 1967, Taiwan had a per capita GNP of as low as about US$260. There were no doctoral programs at Taiwan universities, only 170 master's programs. However, when Taiwan had a per capita GNP of US$964 in 1975, 90 doctoral programs had already been created at Taiwanese universities, and 32 doctoral degrees were awarded in that year. Though doctoral education developed steadily in the following 20-year period—for example, in 1995, there were 578 doctoral programs nationwide, and 1,053 doctoral degrees were awarded—compared with some other developed countries, the establishment of doctoral training in Taiwan is still small and weak. Despite its growth, the number of students seeking graduate education abroad, and efforts to entice them to return, is evidence that doctoral education in Taiwan far from satisfies the needs of economic development and the demands of young people for advanced studies.

A majority of Taiwanese students go to the United States; table 4 and figure 2 show that the total number of doctoral degrees (9,847) awarded by American universities to students from Taiwan is as much as twice the number (4,481) awarded by Taiwanese universities in the past 20 years. The United States provides approximately 77 percent of Taiwan's doctoral degrees in natural science and engineering (S&E) (NSF 1993, p. 25). However, Taiwan built up its advanced degree capability and expanded its doctoral-level training in the mid-1980s. The recent trend shows that the number of home-awarded doctoral degrees has been approaching that awarded in the United States. In 1995, the number of U.S.-awarded doctoral degrees decreased for the first time, dropping from 1,576 in 1994 to 1,485 in 1995.

## S&E Field-of-Study Structure of Home-Awarded Graduate Degrees

As noted previously, centralization is one of the major features of Taiwan's higher education system. The government controls enrollments in each field and directs the development of higher education to meet the needs of society. As early as the 1950s and 1960s, the Taiwanese higher education structure was biased toward the humanities and social sciences rather than science and technology, as the economy in Taiwan was still labor intensive. The Ministry of Education was influenced by a 1962 Stanford report which suggested that in the 1960s there would be a surplus of graduates from the humanities and social sciences, but a shortage from S&T (Law 1996). Since then, the government has been channeling students into such marketable fields as engineering, natural sciences, and—more recently—business.

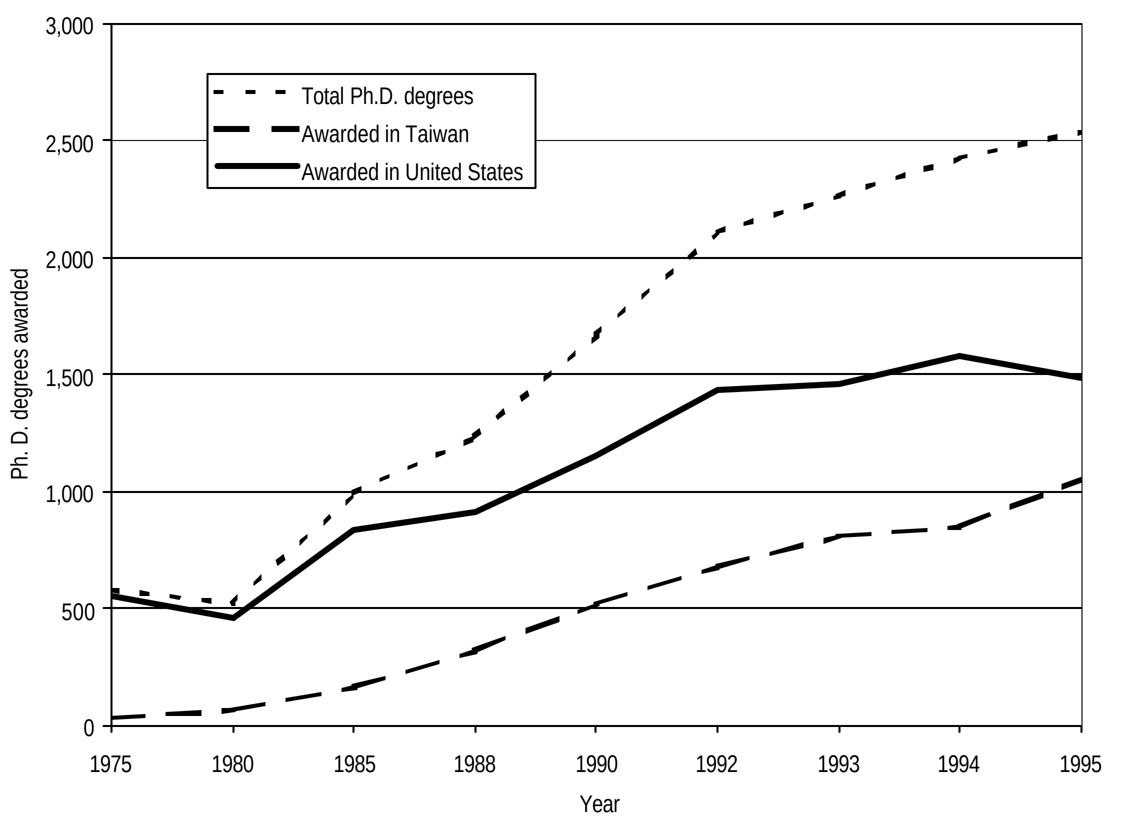
The statistics in table 5 and figure 3 show that the percentage of master's degrees awarded in the social sciences (out of all S&E fields) slowly decreased from 13 percent in 1975-80 to 10.1 percent in 1991-95, while that of doctorates dropped from 11.1 percent to 7.4 percent. On the other hand, the share of master's degrees awarded in the natural sciences and engineering (out of all S&E fields) slowly increased from 67.9 percent in 1975-80 to 71 percent in 1991-95, while that of doctorates rose from 70 percent to 74.4 percent. Within the five broad S&E fields, engineering has consistently had the largest degree population in the past 2 decades. During the period 1991-95, the proportions of master's and doctoral degrees in engineering reached 55 percent and 56.1 percent, respectively. Natural sciences ranked second after engineering, with proportions of master's and doctoral degrees of 16 percent and 18.3 percent, respectively. The

**Table 4. Ph.D. degrees awarded at home and in the United States, 1975-95**

| Year | 1975 | 1980 | 1985 | 1988 | 1990 | 1992 | 1993 | 1994 | 1995 | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| Total Ph.D. degrees | 580 | 519 | 994 | 1,231 | 1,667 | 2,109 | 2,264 | 2,424 | 2,538 | 14,326 |
| Awarded in Taiwan | 32 | 64 | 161 | 319 | 518 | 678 | 808 | 848 | 1,053 | 4,481 |
| Awarded in United States | 550 | 455 | 833 | 912 | 1,149 | 1,431 | 1,456 | 1,576 | 1,485 | 9,847 |

**SOURCE:** Ministry of Education, *Educational Statistics of the Republic of China,* 1997, pp. 24-5; and National Science Foundation, Division of Science Resources Studies, Survey of Earned Doctorates.

**Figure 2. Ph.D. degrees awarded at home and in the United States, 1975-95**




**SOURCE:** Ministry of Education, *Educational Statistics of the Republic of China,* 1997, pp. 24-5; and National Science Foundation, Division of Science Resources Studies, Survey of Earned Doctorates.

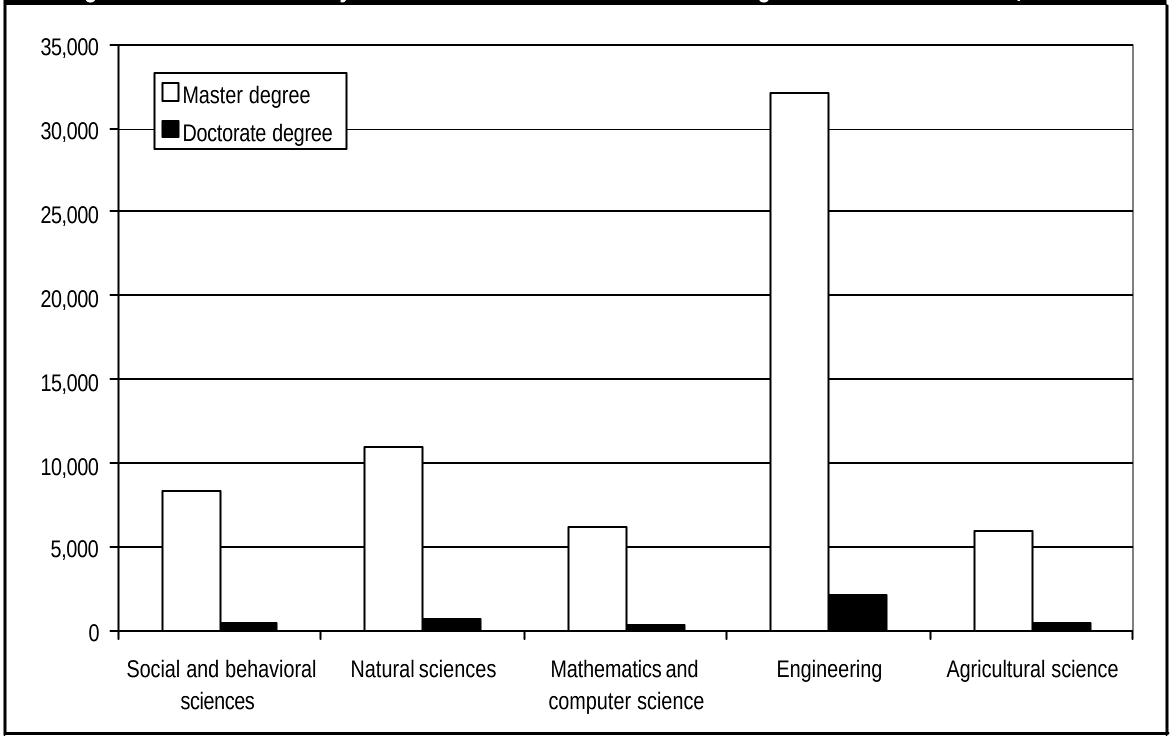
proportions for agricultural science used to be higher before the mid-1960s. After Taiwan began industrializing in the late 1960s, the percentage of agriculture degrees gradually dropped. In the period 1991-95, the shares of master's and doctoral degrees in agriculture were 8.4 percent and 9.6 percent, respectively.

**Table 5. S&E field-of-study structure of master's and doctorate degrees awarded in Taiwan, 1975-95**

| Year | Total S&E degrees | | Social and behavioral sciences | | Natural sciences | | Math. and computer science | | Engineering | | Agricultural science | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Number | Percent | Number | Percent | Number | Percent | Number | Percent | Number | Percent | Number | Percent |
| | Master's degree | | | | | | | | | | | |
| Total................ | 63,399 | 100.0 | 8,276 | 13.0 | 10,930 | 17.2 | 6,141 | 9.7 | 32,148 | 50.7 | 5,904 | 9.3 |
| 1975-80....... | 6,333 | 100.0 | 1,304 | 20.6 | 1,478 | 23.3 | 548 | 8.6 | 2,127 | 33.6 | 876 | 13.8 |
| 1981-85....... | 9,404 | 100.0 | 2,083 | 22.1 | 1,780 | 18.9 | 646 | 6.7 | 3,988 | 42.4 | 907 | 9.6 |
| 1986-90....... | 17,175 | 100.0 | 1,817 | 10.6 | 2,796 | 16.3 | 1,740 | 10.1 | 9,259 | 53.9 | 1,563 | 9.1 |
| 1991-95....... | 30,487 | 100.0 | 3,072 | 10.1 | 4,876 | 16.0 | 3,207 | 10.5 | 16,774 | 55.0 | 2,558 | 8.4 |
| | Doctorate degree | | | | | | | | | | | |
| Total................ | 4,164 | 100.0 | 464 | 11.1 | 732 | 17.6 | 322 | 7.7 | 2,183 | 52.4 | 463 | 11.1 |
| 1975-80....... | 139 | 100.0 | 43 | 30.9 | 25 | 18.0 | 2 | 1.4 | 40 | 28.8 | 29 | 20.8 |
| 1981-85....... | 345 | 100.0 | 77 | 22.3 | 55 | 15.9 | 14 | 4.0 | 134 | 38.8 | 65 | 18.8 |
| 1986-90....... | 1,105 | 100.0 | 154 | 13.9 | 181 | 16.4 | 83 | 7.5 | 564 | 51.0 | 123 | 11.1 |
| 1991-95....... | 2,575 | 100.0 | 190 | 7.4 | 471 | 18.3 | 223 | 8.7 | 1,445 | 56.1 | 246 | 9.6 |

**SOURCE:** National Science Foundation, Division of Science Resources Studies, Survey of Earned Doctorates.

**Figure 3. S&E field-of-study structure of master's and doctorate degrees awarded in Taiwan, 1975-95**




**SOURCE:** Ministry of Education, *Educational Statistics of the Republic of China,* Annual Series.

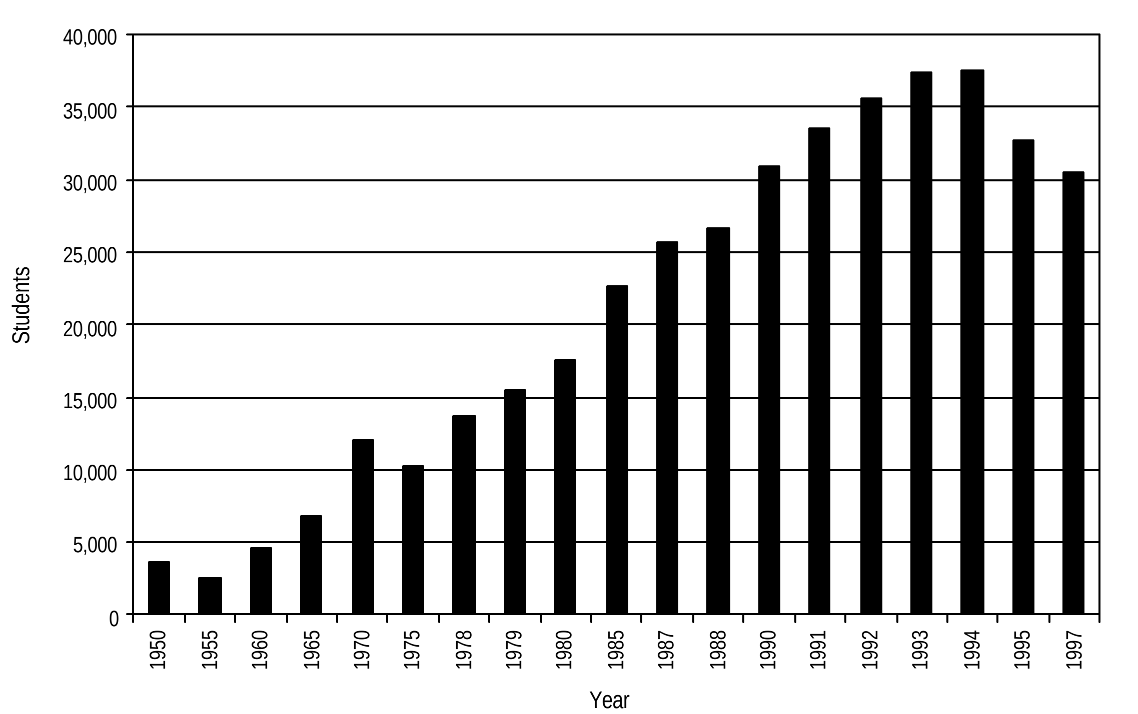
The issue of governmental intervention in the development of higher education has been controversial. Since economic development has been at the top of the government's agenda, it has been an important factor in determining graduate enrollment in different fields. Although many people in Taiwan believe that higher education should be geared to the nation's economic development, the government has been criticized for being too involved in the projected technical manpower needs of society, and thus overlooking the importance of the social sciences and humanities. Critics argue that policies regarding changes in higher and graduate enrollments need to be made on a broad basis, taking the social and cultural development of the nation into consideration (Chen 1991).

## Overseas Study and International Mobility of Scientists and Engineers

The phenomena of study abroad and international mobility of scientists and engineers in Taiwan are correlated and have been affected by many societal factors. For example, it is a Chinese tradition that parents are respected and honored if they avail their children of advanced education or overseas study. Thus, the demand for higher education in Taiwan has been growing in the past 4 decades. However, due to the small and limited higher education establishment, as well as political restrictions, there are limited opportunities for higher and graduate study in Taiwan. Students mainly study abroad to fulfill their own and their parents' ambitions. American universities enroll a huge majority of them (over 90 percent) and account for approximately 77 percent of Taiwan's doctoral degrees in natural sciences and engineering (NSF 1993).

The steady annual increase of students from Taiwan between 1950 and 1997 is shown in figure 4. In the peak year of 1994, 37,581 Taiwanese students were enrolled in 921 accredited colleges and universities in the United States. In 1995 and 1996, enrollment dropped to 32,702 and 30,487, proportionally reflecting the decrease of advanced students coming to the United States. These students instead chose to study in Taiwan. A large number of Taiwanese students have chosen to stay and work in America upon successful completion of their studies. Some of them have become naturalized American citizens, taking challenging, well-paying positions in various sectors ranging from higher education and research organizations to well-recognized business corporations (Li 1995).

**Figure 4. Taiwanese students studying in the United States, 1950-97**



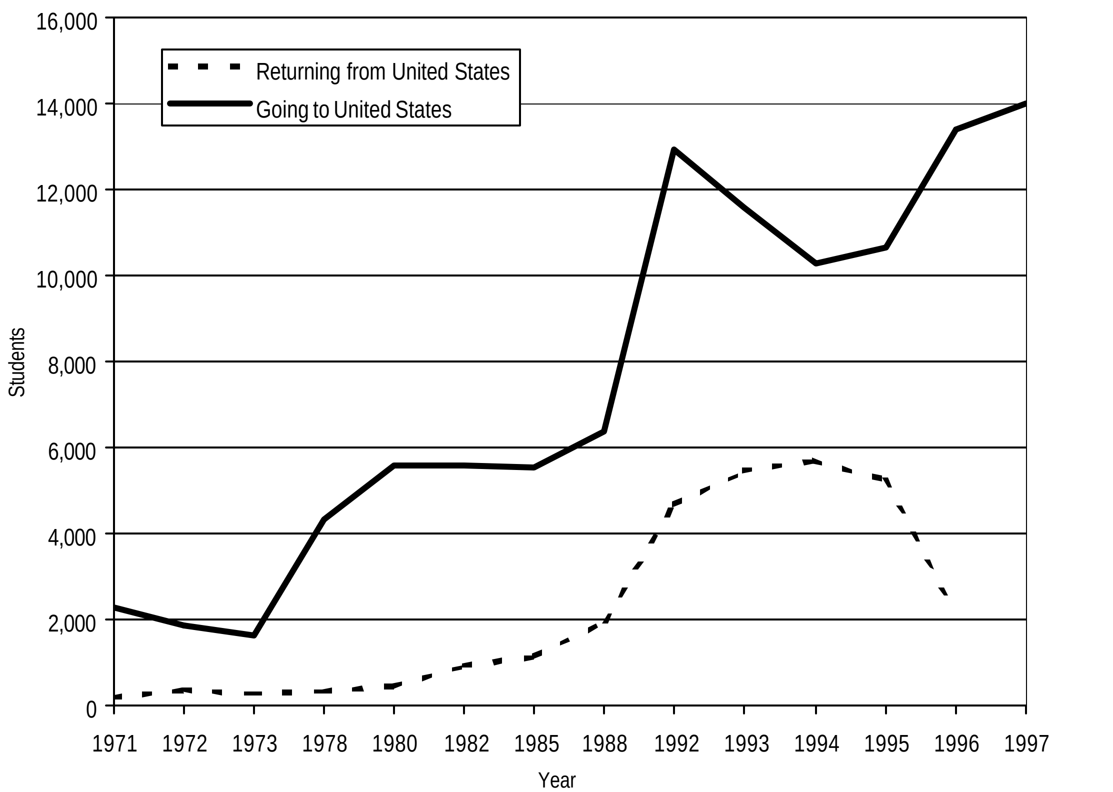

**SOURCES:** Cultural Division of Taipei Economic and Cultural Representative Office in the United States, *Cultural & Educational Digest,* January 1998, p. 28; Chen-ching Li, "Returning Home After Studying in the USA: Reverse Brain Drain in Taiwan," *Cultural & Educational Digest,* pp. 20-24. Cultural Division of Taipei Economic and Cultural Representative Office in the United States, *Cultural & Educational Digest,* 1995; and Chen-ching Li, "Toward a Rejuvenated National Goal: Reform and Internationalization of Higher Education in Taiwan, Republic of China," *Cultural & Educational Digest,* pp. 34 - 42, Cultural Division of Taipei Economic and Cultural Representative Office in the United States, 1997.

Figure 5 shows the historical trends of Taiwanese students entering and leaving the United States in the period between 1971 and 1997. Until the 1990s, Taiwan had suffered a serious "brain drain" for almost 40 years. It was reported that, between 1950 and 1980, the Ministry of Education issued approvals to 63,061 college graduates to study abroad; only 7,240 of them returned. During this period, the brain drain from students not returning from study abroad reached a high of 90 percent. The brain drain slowed gradually in the 1980s: it decreased to 80 percent between 1981 and 1987 (Chen 1991).

However, it was only at the end of 1980s that Taiwan started to benefit from its international students and their connection. A return flow of American-trained scientists and engineers has occurred in recent years. There are a number of societal variables that appear to account for this change. The most important variable is the economy. The statistics in figures 5 and 6 show a close correlation between economic development and return flow. The strong increase of per capita GNP since the late 1980s put Taiwan in the group of NIEs. Rapid economic development has offered a great number of job opportunities for returning students with advanced degrees and professional expertise. The nationwide Ten Construction Project infrastructure development, together with the establishment of the Hsinchu Science-Based Industrial Park in 1980, has opened many new avenues for young returned students to start new challenging careers. According to the 1994 annual report of the Science-Based Industrial Park, 1.05 percent of the employees hold Ph.D. degrees, 10.08 percent have master's degrees, and 17.92 percent have bachelor's degrees. Of the total 34,564 employees hired to work in the Science-Based Industrial Park, a large number of junior professionals were from the United States (Li 1995).

The political situation is the second important factor that has affected study abroad and the international mobility of scientists and engineers in Taiwan. As Taiwan's international status is unusual, its development has always been affected by the triangular relations among the People's Republic of China (PRC), the United States, and Taiwan itself. For example, in 1972 there were 367 stu-

**Figure 5. Taiwanese students entering the United States versus returning to Taiwan, 1971-97**




**SOURCE:** Ministry of Education, Educational Statistics of the Republic of China, 1997, pp. 54, 56-57, 60; Chen-ching Li, "Returning Home After Studying in the USA: Reverse Brain Drain in Taiwan," *Cultural & Educational Digest,* pp. 20-24 Cultural Division of Taipei Economic and Cultural Representative Office in the United States, *Cultural & Educational Digest,* 1995a; and Cultural Division of Taipei Economic and Cultural Representative Office in the United States, June 1998, p.11.

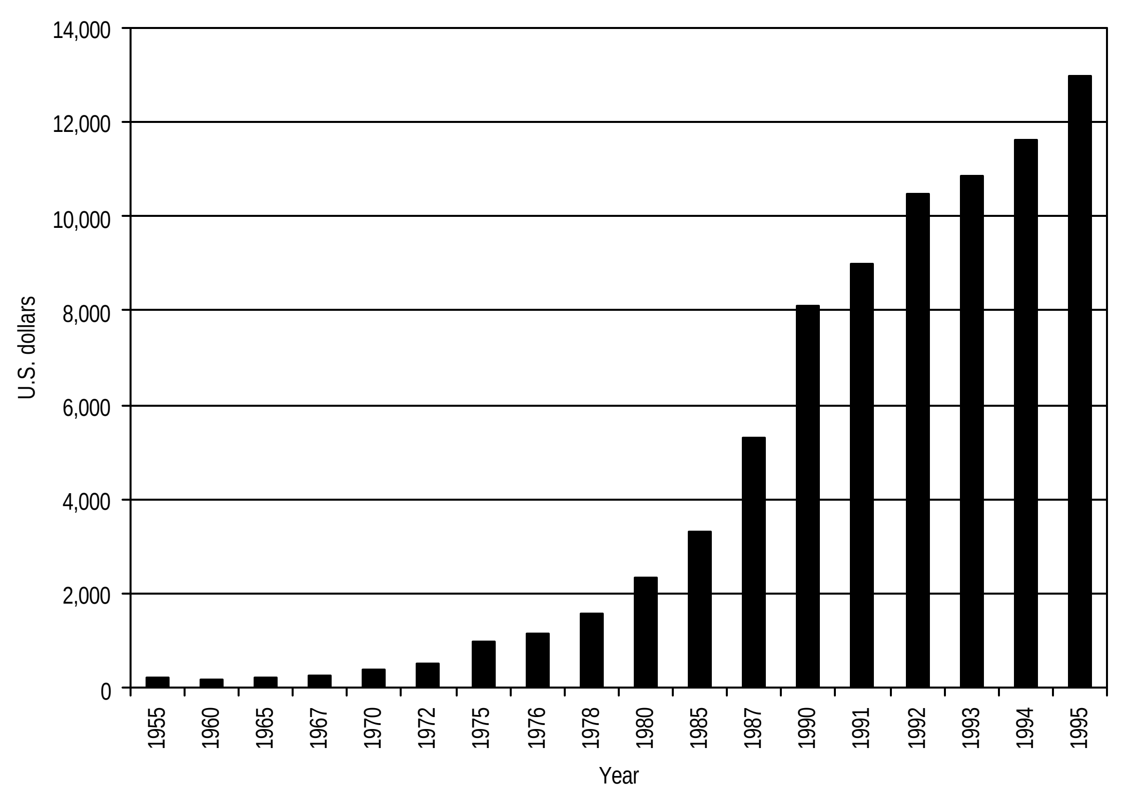
dents with advanced degrees going back home. However, the so-called "Nixon Shock"[2] of 1972 caused the number to drop from 367 to 276 the following year (Li 1995). The political impact lingered for almost a decade, continuing even when former president Carter announced normalization of relations between the United States and the PRC in 1978: this was followed by an immediate decline in the number of returning students from 431 to 331 in that year. Only when the U.S. Congress enacted the Taiwan Relations Act in 1979 did the number of returning students gradually begin to rise. In 1987, coupled with an economic boom, Taiwan lifted martial law and some other restrictions, and the number of returning students soared from 1,977 in 1988 to 4,674 in 1992. It later reached 5,700 in the peak year of 1994.

After 1995, however, the number of returning students dropped sharply to 2,185 in 1996. The reasons for this decline in returning students seem complex. There are three possible explanations. First, the job market in Taiwan for returning students is not as exciting as it was before 1992. The returnees had to compete for fewer jobs. Second, the economy in America has steadily improved in recent years, providing more job opportunities. Third, but not necessarily least, is the fact that the decline could be attributed to the military crisis on the Taiwan Strait in 1996.

At the same time that the return flow increased, the Taiwanese government lifted restrictions governing students going overseas and allowed high school graduates to go abroad to pursue undergraduate studies. As a result, the number rose from 6,382 in 1988 to 12,936 in 1992. After that, as Taiwan increased its internal capacity for graduate education in science and engineering, more and more students decided to stay home for graduate studies instead of traveling abroad. A recent rise is probably attributable to two factors. One is the growing number of graduates from junior colleges and high schools applying

[2] Under the secret and careful arrangement of Dr. Henry Kissinger, former president Richard M. Nixon paid a visit to China in 1972 and signed the historic Shanghai Communiqué, stating that the United States acknowledged that there is only one China, and that Taiwan is part of China. The abrupt U.S. recognition of the PRC shocked the whole world - especially Taiwan - with an unpredictable political impact.

**Figure 6. Per capita GNP in Taiwan, 1955-95**




**SOURCE:** Chen-ching Li, "Returning Home After Studying in the USA: Reverse Brain Drain in Taiwan," *Cultural & Educational Digest,* pp. 20-24 Cultural Division of Taipei Economic and Cultural Representative Office in the United States, 1995a.

for undergraduate programs, or only for summer sessions, in American universities. The other may be the affect of unstable relations with mainland China, especially during and after the military crisis on the Taiwan Strait in 1996.

Special mention should be made of the role of the Taiwanese government in attracting the return of students. The government has made a concerted effort to attract back S&T personnel educated in the United States. Its Manpower Planning Department assesses required manpower with advanced degrees for strategic industries, plans for recruitment from abroad, and expands S&T university education in Taiwan accordingly (NSF 1993). The government has also set up the National Youth Commission, affiliated with the Executive Yuan (which is like the cabinet) to recruit university graduates with Ph.D. and master's degrees to join in national development. The commission offers a subsidy in airfare for both the graduating student and his/her spouse, plus up to two children, if they decide to go back to Taiwan for career development. The commission has established channels of communication with overseas scholars so they can be recruited more easily when their services are needed. By the end of January 1998, a total of 15,914 students and professionals abroad had joined the commission's database network (Cultural Division of Taipei 1998, p. 13).

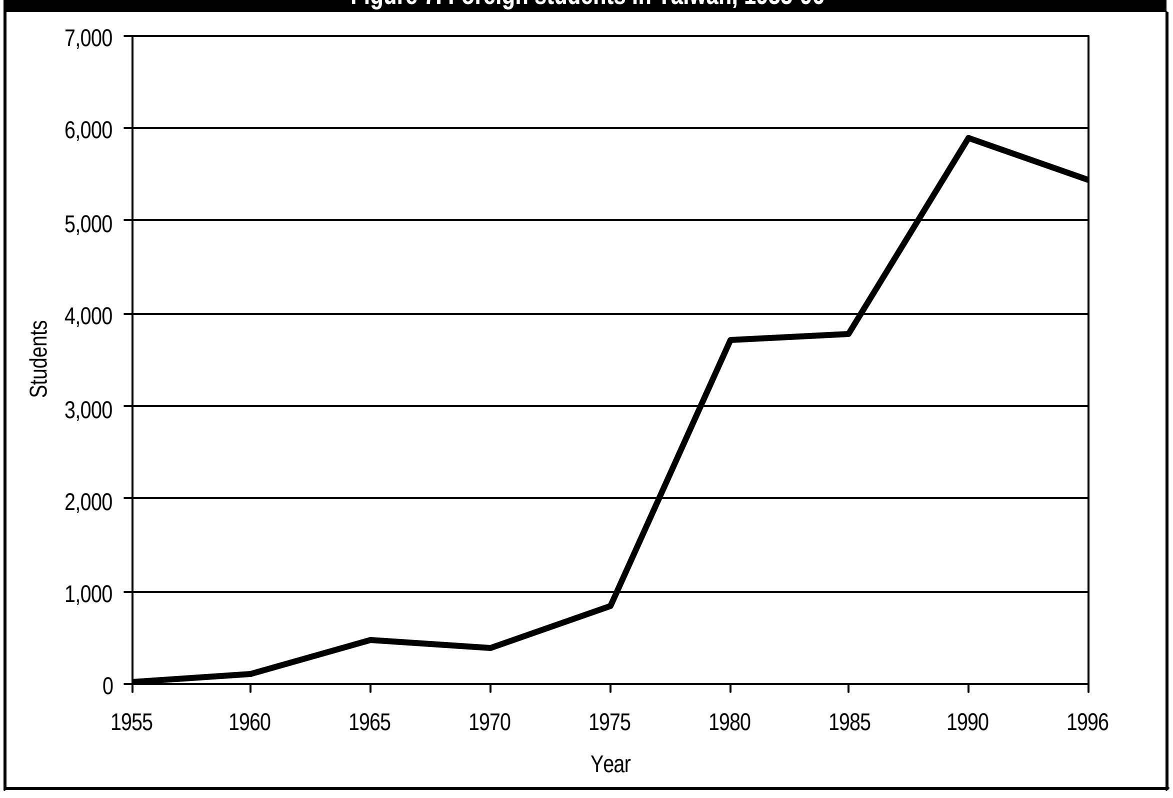
Besides attracting foreign-educated students to return home, Taiwan also imports S&T through the recruitment of foreign scientists and engineers, particularly from developed countries, to work in Taiwan. Since the promulgation of the "Guidelines for Long-Range Development of Science" in 1959, overseas scientists and engineers have been brought into Taiwan's higher education system as special-chair lecturers, national research professors—to guide research work and hold research seminars on a yearly contractual basis—or as visiting professors to give lectures on a short-term basis. The demand for overseas scientists and engineers increased sharply when Taiwan began industrializing: 413 expatriate scientists were employed between 1963 and 1970, and 2,783 between 1971 and 1980. In 1987, 399 foreign experts were invited to teach or supervise research work in Taiwan's higher education institutions. Meanwhile, "several top mainland scientists and engineers were employed to do research in Taiwan after it resumed non-diplomatic (in-formal) relations with mainland China in the late 1980s" (Law 1996). According to the latest report, beginning July 1, 1998, Taiwan will lift more restrictions in order to import more scientists and engineers from abroad and from mainland China (Cultural Division of Taipei 1998, p. 15).

To increase its international involvement, Taiwan has also provided scholarships for international scholars, researchers, and students to study in Taiwan. The historical trend is shown in figure 7. Currently, over 5,000 foreign students are studying at Taiwan's colleges and universities. Most of them are enrolled in the fields of the humanities, social sciences, and languages. Recently, the Ministry of Education has decided that, starting with the 1998-99 academic year, it will provide a scholarship (with each person receiving about US$5,000 each month) to 20 foreign professors and researchers and 100 foreign students each year to encourage them to conduct research or study in Taiwan (Cultural Division of Taipei 1998, p.11).

## Conclusion

In the past 40-plus years, higher and graduate education in Taiwan have experienced rapid development. Since the political reform that took place in the late 1980s, Taiwan's higher education system has gradually turned to decentralization, democratization, and internationalization. However, the higher education system in Taiwan is relatively small, and it remains dependent on other countries for much of its advanced training. For economic and political reasons, many students remained abroad after they completed their studies for many years, and Taiwan used to suffer from a significant brain drain; things have changed, however, in recent years. The rapid economic development in Taiwan offers a great number of job opportunities for returning students with advanced degrees and professional expertise. More and more students return home, and Taiwan has benefited from the reverse flow of its overseas students and researchers in recent years. Countering this trend, however, have been international politics affecting overseas study and the international movement of scientists and engineers in Taiwan. This influence will continue as long as the issue of Taiwan's relationship to the PRC remains unresolved. Finally, whether the Asian economic crisis of 1998 will affect patterns of overseas study and the movement of scientists and engineers in Taiwan should be monitored.

**Figure 7. Foreign students in Taiwan, 1955-96**




**SOURCE:** Ministry of Education, *Educational Statistics of the Republic of China,* 1997, pp. 44-46.

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