Japanese Educational Patterns in Science and Engineering

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Although the Japanese Ministry of Education (*Mombusho*) publishes a great deal of information on the status of Japanese education, there seems to be a continuing lack of understanding among non-Japanese about the general patterns of education—especially science education—in Japan (*1*). If only for this reason, the article in *Science* by Findeis on graduate education and research in science and engineering in Japan is both valuable and welcome (*2*). I hope to complement that article by providing some additional information on Japanese education, focusing on the undergraduate level, but placing it within the total context of the Japanese educational system. The point of view will be that of the student (and possibly his parents), who must face a variety of decisions and obstacles in passing through the system.

Let me begin by sketching the broad outlines of the total educational system. Figure 1 presents the system schematically (*3*). It resembles those of most Western nations, with certain obvious variations. Chief among these are the definite division of the lower (called "middle school") and upper levels of the secondary school, and the clearly terminal role of the junior college. Some school population statistics for the entire system in 1971 are given in Table 1 (*4*). A characteristic narrowing of the school population occurs as one ascends through the system. Despite the fact that compulsory education stops at the end of middle school, almost all students complete upper secondary school. This can be seen, incidentally, from the fact that Japan has one of the highest literacy rates in the world. The sharpest and most critical break in the educational pattern occurs at the time of graduation from high school. In 1971, 85 percent of Japanese middle school graduates went on to upper secondary school, but only 26.8 percent (348,848) of the high school graduates went on to junior college or college.

Before examining the critical decision that must be made by the Japanese student and his parents at the time of upper secondary school graduation, let me review some of the important elements of the precollege experience. The Ministry of Education is a strong central force which substantially controls the entire system from kindergarten through graduate or professional school. Its most direct influence is at the precollege levels, where it sets the qualifications for teachers and administrators and the standards for textbooks, curricula, and student advancement. Despite such centralized control, there is considerable local variation in the quality of education. This is dependent chiefly on the affluence of the community supporting the school and on the number of students enrolled. Variability, similar to that in the United States, occurs between rural and metropolitan schools, as well as between one-room schoolhouses in fishing villages and well-equipped schools in population centers.

Through the middle school level, almost all schools (with the exception of kindergartens) are public. In elementary school (*shogakko*: grades 1 through 6) pupils are introduced to the natural sciences, chiefly through nature study, and to succeedingly complex levels of arithmetic. The science courses emphasize an increased understanding of "living things and their environment," "substance and energy," and "the earth and universe." The arithmetic training extends to the beginnings of algebra and statistics. There are no standardized national examinations at the elementary level, but each school is expected to meet established curricula goals of the Ministry of Education. Although standards are thus established, the ability to achieve them depends on the training of the teachers and the facilities available, elements subject to local affluence and interest. In middle school (*chugakko*: grades 7 through 9), the equivalent of American junior high school, every student is expected to complete 140 hours each of science and mathematics for each year of study. In mathematics, students deepen their studies of algebra, geometry, probability, statistics, sets, and logic. Emphasis is on both manipulation and reasoning. In science, students are introduced to the physical world (properties of substances, force and energy, electricity, structure of matter) and to natural systems (life forms, universal systems, earth systems). In both elementary and middle school, emphasis is placed on natural observation (field trips) and on laboratory work. Again, there are no national examinations, but entry into upper secondary school requires an entrance examination, prepared either at the prefectural, local, or private school level.

It is at this point that a major decision, involving student goals and family ambitions, must be made. An understanding of educational opportunities as they relate to Japanese social patterns must be appreciated. A proper step may reduce, for example, the criticality of the decision which must be made at the end of high school. Parents and students who have set their sights on a prestige national university may decide to move to a new location or board their child, so as to enable him to attend a high school which is known for its success in preparing students for that university's entrance examination. Those families who, for reasons of employment, are required to move to a new location away from a "select" school may elect to have their children commute long distances by public transportation to that school. If distances are prohibitive, some parents refuse transfers in order to keep their children in proper schools, while others give up positions in order to move to areas more suitable for their child's educational future. Others decide to avoid the competitive route and seek to enter their child in a private high school already tied to a private university, thereby probably assuring college entrance. Some parents, by way of extending this strategy, enter their child in an affiliated private kindergarten so that he may travel the least arduous route (via affiliated private schools) to a private university. Costs for some private schools in the Tokyo area, including those for entrance fees, annual tuition, and other fees, are given in Table 2 (*5*). Related costs for areas outside of

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Tokyo may be somewhat lower, while costs for public schools are nominal. Although these decisions resemble those that must be made in the United States, they are far more critical in Japan.

There are several kinds of upper secondary schools in Japan: regular public schools, regular private schools, and vocational and special schools. Almost all students with college aspirations attend schools in the first two categories. About 70 percent of the upper secondary school population is involved in general or intensive science studies that could lead to higher educational levels, while the remaining 30 percent are undergoing some sort of terminal training. Students attending schools that provide intensive science and mathematics training seem to have the greatest success attaining college entrance. However, more than 60 percent of those in nonterminal courses will not go on to college, simply because of the quotas established for college entrance.

At the upper secondary school level (*kotogakko*: grades 10 through 12), curricula specifications are published by the Ministry of Education for each course of study. Specifications are given for six mathematics courses, nine regular science courses, and six special science and mathematics courses. The latter set is designed for more intensive study or technical training in special science courses. The ministry requires that a student complete at least six credits of science (one or two courses) and six credits of mathematics (one or two courses) before graduation. But high schools may place additional requirements on students. Certain upper secondary schools, whose stated objectives are to prepare students for college entrance examinations, intensify the science and mathematics experience of their students. Such schools may pitch their whole educational effort at college entrance preparation. Courses at the upper secondary school level are classified either as "general" or "special." Special courses include science, fine arts, music, commerce, fisheries, agriculture, and domestic arts. Most female students in Japan are enrolled in special courses in Commerce and Domestic Arts. Only the special science courses and the general courses lead to college entrance. The other courses are either terminal or lead to junior colleges or special schools which are terminal. This is in marked contrast to the sequence envisaged in the establishment of junior colleges in the United States.

For most students and parents, the time of college entrance is climactic. About 25 percent of all high school graduates enter college or junior college. The percentage who enter college is significantly less, but exact numbers are hard to come by, since applicants try several schools during the same year. Almost 100 percent of all entrants graduate. Entrance into the "right" university leads to the achieve-

Table 1. Japanese school populations in 1971. Numbers in parentheses are included in the totals given for colleges and universities.

Type of school	Schools (No.)	Students (No.)	Teachers (No.)
Elementary	24,540	9,595,021	376,690
Middle	10,839	4,694,250	235,398
Upper secondary	4,792	4,178,327	235,507
Junior college	486	275,256	32,469
College and university	389	1,468,538	122,821
Graduate	(188)	(41,637)	

Table 2. Typical Japanese private school costs (Tokyo area).

Schools	Entrance fee	Annual tuition	Other annual fees	Annual total
Kindergarten		¥100,000 ($377)	¥30,000 ($113)	¥130,000 ($491)
Elementary	¥70,000 ($264)	¥ 80,000 ($302)	¥55,000 ($208)	¥135,000 ($509)
Middle	¥70,000 ($264)	¥ 80,000 ($302)	¥50,000 ($189)	¥130,000 ($491)
Senior high	¥70,000 ($264)	¥ 80,000 ($302)	¥31,000 ($117)	¥111,000 ($419)
Preparatory	none	¥100,000 ($377)	none	¥100,000 ($377)

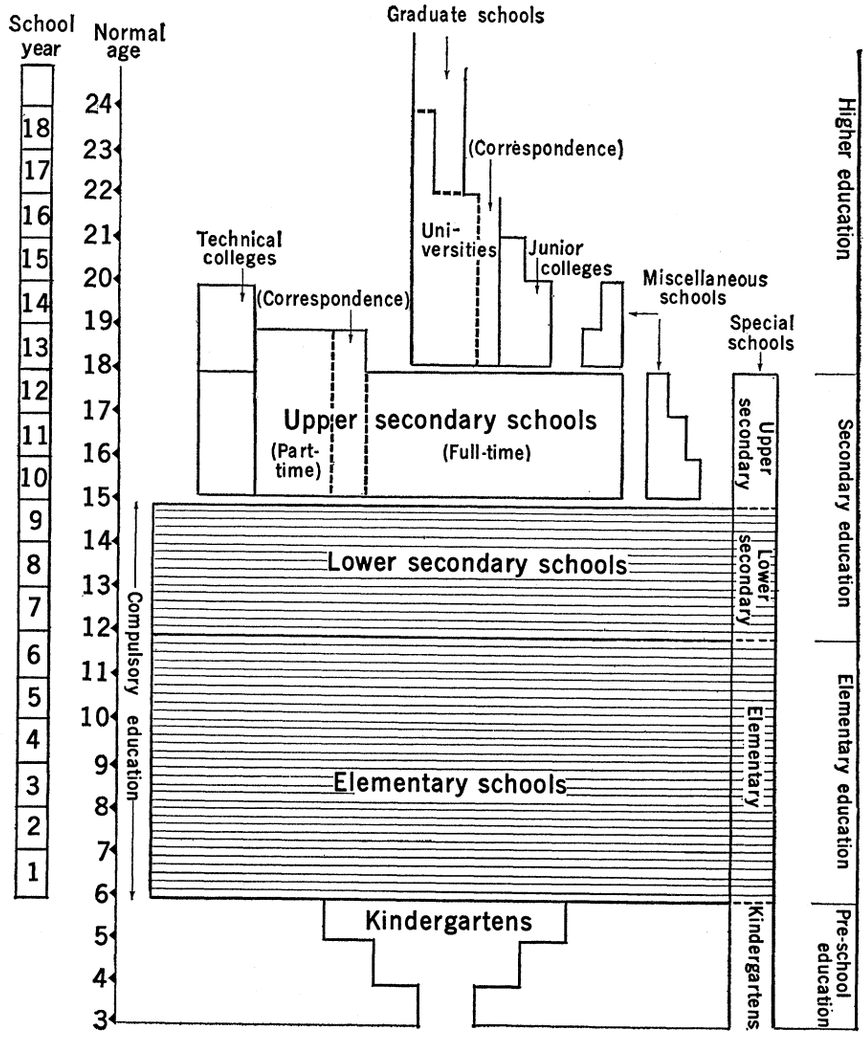

Fig. 1. Organization of the Japanese school system.

ment of career goals. Graduates of the University of Tokyo, for example, who are highest in the academic pecking order, have first choice of the best career openings in government, industry, and graduate study at the same university. It should be recognized that, in Japan, entrance into a particular company or government ministry is a career commitment of much more permanence than that which exists in the United States. In the Japanese pattern, organization and employee are bound to each other. Employees seldom leave their organizations (longevity is a key to advancement), and, in turn, employees are almost never fired. A career may begin prior to college entrance and end at retirement. Is it any wonder that entrance into the right college is critical? Just as some high schools are known for their success with some colleges, some colleges are known for their success with certain government institutions or industrial corporations. The career paths are well marked. It becomes incumbent on the student to find and get into the right career path. The college entrance examination is the key.

Table 3. Some Japanese university costs.

Universities	Examination fee	Entrance fee	Annual tuition and other fees
National universities	¥ 5,000 ($19)	¥ 12,000 ($ 45)	¥ 36,000 ($ 136)
Private university A			
Engineering school	¥ 8,000 ($30)	¥ 80,000 ($302)	¥290,000 ($1094)
Private university B			
Engineering school	¥ 8,000 ($30)	¥100,000 ($377)	¥178,000 ($ 672)
Medical school	¥ 8,000 ($30)	¥100,000 ($377)	¥672,000 ($2536)
Private university C			
Engineering school	¥ 8,000 ($30)	¥ 70,000 ($264)	¥192,000 ($ 725)
Medical school	¥ 8,000 ($30)	¥100,000 ($377)	¥434,850 ($1641)
Private university D			
Medical school	¥10,000 ($38)	¥150,000 ($566)	¥470,000 ($1774)

Table 4. Degrees offered at Japanese universities in 1971.

Degrees offered	Universities (No.)			
	National	Public	Private	Total
Bachelor's	75	33	281	389
Master's	58	12	88	158
Doctorate	27	14	70	111
Bachelor's in science or engineering	48	5	64	117
Master's in science or engineering	39	4	36	79
Doctorate in science or engineering	22	3	26	51

Table 5. Number of undergraduate applicants and entrants to Japanese colleges and universities in 1971.

Colleges and universities	Applications (No.)	Quotas (No.)	Total entrants (No.)	Female entrants (No.)
National	362,767	69,191	65,484	15,151
Public	83,961	8,649	10,321	3,133
Private	1,505,956	143,240	282,016	53,718
Total	1,952,684	221,080	357,821	72,002

Table 6 (left). College entrance quotas for Japanese undergraduates in science and engineering in 1971. Table 7 (right). Japanese undergraduate enrollment in science and engineering in 1971.

Schools	Science (No.)	Engineering (No.)	Total (No.)
National	4,914	19,951	24,865
Public	293	1,200	1,493
Private	4,820	31,210	36,030
Total	10,027	52,361	62,388

Schools	Science (No.)	Engineering (No.)	Total (No.)
National	18,916	76,448	95,364
Public	1,359	5,153	6,512
Private	22,786	219,488	242,274
Total	43,061	301,089	344,150

Table 8. What happened to Japan's 1971 college and university graduates.

Colleges and universities	Graduates (No.)	Continued education		Entered employment	
		No.	Percent	No.	Percent
National	55,592	6,717	12.1	41,746	75.1
Public	9,772	594	6.2	7,582	77.7
Private	207,585	4,330	2.4	165,591	80.1
Total	272,949	11,641	4.5	214,919	79.0

What occurs annually at the time of college entrance examinations can be found in few countries outside of Japan. Students may spend long periods cramming for entrance to particular universities (each having its own set of questions and its own biases). Some students may pay to attend special cram or preparatory schools (*yobiko*).

A student must decide on examination strategies, often with the help of his parents. He must estimate as realistically as possible his capabilities and his competition. Each year the student has a choice of taking the examination for two national universities, one public university, and a limited (by examination date primarily, but also by the need to prepare separately for each examination) number of private universities. Costs for some universities, including those for entrance examinations, entrance fees, tuition, and other fees are given in Table 3. If a student has his heart set on Kyoto University, for example, he may choose to take its entrance examination only. If he fails, he probably will spend the next year (or even two) preparing for succeeding examinations, either in intense isolated study or by entering a preparatory school (*6*). During those times a Japanese house is filled with tension, and the Japanese mother calls this period "examination-heli" time. The "hell" can be amplified if the mother turns out to be the well-known "kyoiku mama" or "education mother," whose ambition for the child may drive him to distraction. If, on the other hand, a student tries to take as many examinations as he can, he is confounded by the uncoordinated timing of these examinations and equally by the uncoordinated announcement of results. For example, a student may be asked to pay full costs for entrance to a private college (sometimes a lesser choice, but more costly) before he knows the results of his national university examination. A final decision, therefore, is often arbitrary despite long-range family planning.

One means of controlling college

entrance is the college quota, established annually by the Ministry of Education for each college and university. The quota is based on school capacity and facilities and on Ministry of Education responses to national needs and school plans. These quotas are strictly adhered to by national universities, but private universities and colleges, somewhat motivated by demand and by prospects of increased funds, are notorious for exceeding their undergraduate quotas. This is one more reason why it is easier to enter a private college or university.

At this point, perhaps a general view of Japanese higher education would be worthwhile. Table 4 shows the number of Ministry of Education approved colleges and universities in 1971 by broad category and by degree offerings (*7*). In Japan, the ministry controls the financing, faculty complement, and student enrollments of national universities, as well as the degree-granting authority of all national universities (*kokuritsu daigaku*), public universities (*koritsu daigaku*), and private universities (*shiritsu daigaku*).

National universities are funded by the national government, and public universities are financed by prefectural or metropolitan governments. Private universities are financed by endowments, private contributions, and student fees. Some private universities appear to be profit-making institutions. Where provided, room and board are a significantly higher cost at private schools.

National universities are generally considered to be the most prestigious, chiefly because they are said to lead to better career opportunities, but also because their standards are more closely monitored. The average student-teacher ratio for national universities is 8:1, whereas it is 29:1 for private institutions. Public and private universities generally have lesser status. This is not to say that all national universities are (in fact or in reputation) considered better than all nonnational universities. There is an informal but widely accepted division of the national universities into so-called first- and second-class institutions. It is clear, for example, that all of the former imperial universities and perhaps six other national universities have the highest status. These are followed in rank by two or three public and possibly eight private institutions. The rankings are informal, except for the former imperial universities, which remain solidly entrenched. The University of Tokyo and Kyoto University have a very special status, something like that of Oxford and Cambridge in England. Ranking has more to do with career opportunity than with quality, although there is surely some correlation with quality. Keio University, for example, is a private university, recognized throughout the country as one of the nation's leading institutions.

Table 9. Applicants and entrants for advanced degrees in Japanese universities in 1971.

Universities	Applicants	Total entrants	Female entrants
	Master's course		
National	21,201	7,411	534
Public	2,312	653	72
Private	10,838	5,065	620
Total	34,351	13,129	1,226
	Doctoral course		
National	2,993	2,437	153
Public	319	237	15
Private	1,592	1,117	88
Total	4,904	3,791	256

The quotas themselves serve to limit the number of applicants, especially to certain national universities. In some national universities, preliminary examinations are given to select those qualified to compete in the actual entrance examination. Table 5 lists the number of college entrants in 1971 and the quotas and number of applications to national, public, and private universities. The ratio of entrants to applicants is much greater for the prestige institutions. Less than 20 percent of the entrants are female.

The quotas for science and engineering result in an additional narrowing of opportunity (*8*). Table 6 gives the quotas for 1971. A science or engineering student considers only those schools with faculties of science (*rigakubu*), engineering (*kogakubu*), or arts and science (*bunrigakubu*). Table 4 shows that in 1971 less than one-third of all approved universities and colleges offered an undergraduate degree in science or engineering (namely those having faculties of science, engineering, or a combination of the two, sometimes called "technology"). There are 48 national, 5 public, and 64 such private institutions. Since a student taking an entrance examination must list his preferred field of study, science and engineering applicants are limited to these 117 institutions; and indeed the examinations for entrance into these institutions include sections that are tailored for these fields. The competition in 1971 for entrance into science and engineering degree programs is reflected in the statistics: 71,623 applications for science and 10,577 entrants; 431,316 applications for engineering and 75,775 entrants. Of these there were only 1,425 female entrants in science and 603 in engineering.

The announcement of grades for the entrance examinations simply lists the results by faculty in "quality segments." For national, public, and many of the private institutions, entrance is dependent upon the determination of cut-off points roughly consistent with the quotas established. For some private universities (especially those involved in medical education), however, an accepted although not official system of selection has come into being. First, a cut-off is established for the clearly superior applicants. Then, a second group is identified which greatly exceeds both the ministry's quota and the institution's real capacity. A series of interviews of both students and parents in this second group follows. Selection seems to be based on a combination of judgment about student capabilities and the financial contribution which his parents are willing to make to the institution, although the fact of contribution does not guarantee admission. The pressures for entrance are sufficiently strong so that some parents are willing to make substantial contributions. Again, some parents have avoided these pressures by having their children enter private universities via a line of affiliated precollege private schools (*9*).

Eventually the new freshman class for Japanese universities, including those for science and engineering, is determined. These then become a part of the total undergraduate enrollment. In 1971 there were 281,167 national,

Table 10. Graduate enrollment in Japanese universities in 1971.

Universities	Master's course (No.)	Doctoral course (No.)	Total (No.)	Total male (No.)	Total female (No.)
National	15,625	7,858	23,483		
Public	1,400	865	2,265		
Private	11,472	4,417	15,889		
Total	28,497	13,140	41,637	37,873	3,764

45,176 public, and 1,077,843 private undergraduates, totaling 1,404,186, 20 percent of whom were girls. Table 7 provides data on undergraduate student enrollments in science and engineering for 1971, roughly 25 percent of the total undergraduate enrollment. These data apply only to those seeking undergraduate degrees in science and engineering and exclude a significant number undergoing scientific training in medicine and allied fields and in such areas as agricultural engineering and fisheries science.

I will not dwell on the content of undergraduate science except to note that variation in quality is more dependent on the faculty differences than on differences in facilities, although a few institutions (especially those which are affluent because of good government or private support) are far better equipped than the average. Most universities and colleges at the undergraduate level are organized by departments within faculties, but some of the older universities, such as the former imperial universities, retain the traditional *koza* system at the graduate level. The koza is a basic unit headed by a professor with an accompanying complement of an assistant professor and assistants, much like an endowed chair in an American university.

The major elements of the undergraduate science or engineering experience may be described briefly. All freshman and sophomore students follow a course of general studies. At the University of Tokyo, freshmen and sophomores are actually under a faculty of general education. This pattern was copied from the United States after World War II and has been criticized by Japanese educators who favor "specialization" from the beginning. Students dedicated to a particular faculty (for example, science) may change their major during the first 2 years only under the condition that the change does not alter the established quotas. The subsequent 2 years are entirely within the faculties of science or engineering. During this time, student attendance at lectures is usually required, but a record of attendance is often not maintained. A student's participation in laboratory or fieldwork is essential, however, and attendance is closely monitored. Completion of a certain number of set courses is required during each 2-year period. A student may take virtually similar courses and end up with either a B.S. or a B.E., depending on the faculty in which he matriculated. The normal first 2 years of study include four semester courses in the humanities, four semester courses in the social sciences, four semester courses in the natural sciences, two semester courses in a foreign language, and two semester courses in physical education. The second 2 years is the period of professional or "major" education. If the student enters the faculty of science, his required course work (depending on his major) ranges between 12 and 20 specified courses in his field of specialization, including a graduation thesis in some cases, and four to ten electives in science, plus an unspecified number of free courses. If the student enters the faculty of engineering, he has a similar set of requirements, only this time with a totally different set of teachers and laboratories. Actual content and requirements are left to the professor teaching the course. A student is usually required to complete at least 124 credit hours for graduation. The passing of a final examination usually signifies the completion of a course requirement. Students may retake failed examinations several times. If they continue to fail, they are required to retake the course. This partially accounts for the near 100 percent nonfail statistic. Some students may take on special laboratory research projects at the graduate level or in university-attached research institutes. Such arrangements are dependent on relationships established with research professors. Students graduate upon completion of course requirements. No final, overall university examination is given.

Table 11. Graduate enrollment in science and engineering in Japan in 1971.

Course	Science (No.)	Engineering (No.)	Total (No.)
Master's	2,869	10,606	13,475
Doctoral	2,338	2,312	4,650
Total	5,207	12,918	18,125
	Male		
Combined graduate	4,857	12,856	17,713
	Female		
Combined graduate	350	62	412

Most of those who complete undergraduate study do not go on to graduate work. An overwhelming proportion (79 percent in 1971) accept employment. Not only are graduate study opportunities limited, but the lure of industry, business, and government is strong enough to attract most graduates, including those in science and engineering. There appears to be little financial value in a graduate degree, as advancement is usually a function of company training and longevity. Entrance into a company or a government position is chiefly dependent upon entrance examinations and interviews, although school records and recommendations have some influence. Of course, there are recognized "paths," as described previously, between certain schools and certain positions in industry and government. Recruitment examinations are a regular practice in Japan, and for certain positions the competition among graduates is intense. Table 8 provides the data on what happened to Japan's 1971 college graduating class. The figures show that, although less than 5 percent of total college graduates went on to graduate study, about 12 percent of national university graduates did so. Less than 10 percent of all students who went on to graduate study were female. Although the percentages of graduates who enter employment from each type of school are roughly equal, it is clear that private schools serve as feeders to industry. A larger percentage of national university graduates enter into public service.

Entrance to graduate study follows

Table 12. What happened to Japan's 1971 recipients of graduate degrees.

Universities	Graduates (No.)	Continued education		Entered employment	
		No.	%	No.	%
		Master's degrees			
National	6,838	2,106	30.8	4,082	59.7
Public	529	137	25.9	334	63.1
Private	3,456	614	18.1	1,987	57.8
Total	10,823	2,857	26.5	6,403	59.3
		Doctorates			
National	1,897			1,297	66.0
Public	269			178	68.4
Private	805			487	66.2
Total	2,971			1,962	60.5

a pattern similar to that of undergraduate study, except there is a considerable narrowing of opportunity. Again there are entrance quotas established by the Ministry of Education, and again there are entrance examinations sometimes individually devised by each faculty or department. Table 9 gives the 1971 data for applicants versus entrants for both master's and doctoral courses. About 38 percent of all applicants (except medical students) become master's candidates, and 77 percent of all applicants for entrance to a doctoral course are accepted for candidacy. A student must complete his master's courses before becoming a doctoral candidate. Most graduate students do their graduate work at the same institution at which they were undergraduates. The entrance examination questions are usually biased in that direction. The method of selection for graduate study at national, public, and private schools depends entirely on examination scores and recommendations. No special family subsidization is required for private schools.

Tables 10 and 11 provide data on 1971 enrollments in Japan's 188 graduate schools, and on comparable enrollments for graduate science and engineering students for the same period. About 43 percent of all graduate students are in these fields.

A good descriptive analysis of graduate education and some postdoctoral patterns in science and engineering may be found in the article by Findeis (*2*), so there is no need for further description here. Table 12 provides data on what happened to the 1971 recipients of master's and doctoral degrees. About 60 percent of each level went into employment, and 26.5 percent of the new master's went on to doctoral study. Table 13 provides information on the numbers who received graduate degrees in science and engineering in 1969, the latest year for which such statistics are readily available (*10*). No data are available on the subsequent activities of these degree recipients.

I have attempted to describe a system which is now very much in flux. Current criticism, both domestic and foreign, of the entrance examination pressures has resulted in efforts to free the system from its relatively rigid form of selection and advancement. Recently the Association of National Universities (Japan), after some self-analysis, recommended that a nationwide preliminary entrance examination for national universities be introduced.

Table 13. Recipients of graduate degrees in science and engineering from Japanese universities in 1969.

Degree	Science (No.)	Engineering (No.)	Total (No.)
Master's	1,267	3,981	5,248
Doctorate	516	609	1,125
Total	1,783	4,590	6,373

The proposal is to be tried in 1975. In addition, the Ministry of Education, after being criticized (*11*) by the OECD (Organisation for Economic Cooperation and Development), has introduced two concepts which, for Japan, challenge existing patterns. The first provides for the transfer of 1 year's credits from any approved Japanese university to another. Transfers are permissible, in special cases, even from foreign institutions. No Japanese university has yet availed itself of these options, but this could introduce a mobility heretofore unheard of in Japanese education. The second concept announced by the Minister of Education, as yet untried, is a proposal that the new national university which is now under development in Tsukuba City, north of Tokyo, be directed by an autonomous board of regents. This, then, would be the first university supported by government funds with significant independence from the ministry. The ministry has already issued new guidelines which would not only strengthen the autonomy of most national universities, but would also involve university academic committees in promoting the process of educational reform (*12*).

At the graduate level, there are also indications that the koza system is breaking down. Many koza professors have given a good deal of freedom to their assistant professors. Some assistant professors are recognized as heading their own "research groups." Some kozas are disappearing as an incumbent professor retires. In their place there seem to be loose arrangements, roughly resembling standard American university departments but not quite fully established. The trend is away from the koza system.

There are many more indications of change, but these are presently in the form of criticism and unrest (*13*). There is no doubt that change is desired, is being considered, and will come. But present patterns have been highly successful in meeting Japanese national needs. It is unlikely that change will be revolutionary. Evolution is much more the Japanese way.

References and Notes

1. The Ministry of Education, Tokyo, issues irregularly in English a number of publications on Japanese education. The latest issues of the most pertinent of these are *Education in Japan* (1971); *Revised Course of Study for Elementary Schools in Japan* (1969); *Revised Course of Study for Lower Secondary Schools in Japan* (1969); *Revised Course of Study for Upper Secondary Schools in Japan* (1971); *Educational Standards in Japan* (1970); and *Outline of Education in Japan* (1972). The Japan Society for the Promotion of Science, Tokyo, has issued a *Directory of Colleges and Universities in Japan* (1972).
2. A. F. Findeis, *Science* **177**, 583 (1972).
3. *Education in Japan* (Ministry of Education, Tokyo, 1971).
4. Data treated in this article, except where another reference is given, were developed from information in Japanese in *Mombu Tokei Yoran* [Summary of Educational Statistics] (Ministry of Education, Tokyo, 1972).
5. All conversions are at the current rate of about ¥265 to $1. If further revaluation were to occur, the dollar value would increase and obviously affect comparative statistics, but within the domestic economy, revaluation's most telling effect is to accelerate the inflationary tendencies in the nation, including those in education. The data in Tables 2 and 3 were developed by direct inquiry during the fall of 1972. These costs have since increased substantially.
6. A student, having once failed to enter college, but still seeking entrance is called a *ronin*. This is an allusion to his status as an unattached person, much as the former samurai were called *ronin* when they had no ties to a lord.
7. These data were collected from various listings in the *Directory of Colleges and Universities in Japan* (Japan Society for the Promotion of Science, Tokyo, 1972).
8. The term "science," as used in this paper and in the Japanese educational system, is broadly inclusive of all the mathematical, physical, and biological sciences, but it is restricted to those disciplines as they are taught in the faculty of science.
9. A significant number of high school graduates choose to enter directly into private medical and dental schools. The costs of qualifying entrance examinations and tuition are possibly the highest in the Japanese educational system. Such a student will receive a Bachelor of Medicine or Dentistry in 6 years, of which 2 years are for general education and the remaining 4 are for medical or dental training. At this point, after passing national licensing examinations, many elect to begin medical or dental practice. Some students and some practitioners will continue on in their private medical or dental schools for an additional 4 years of graduate training, at which time they will receive a Doctor of Medicine or Dentistry. It is possible for a Bachelor of Medicine or Dentistry from a private school to enter a national university for graduate medical or dentistry training, or vice versa, but such cases are rare. Most graduate students in medicine or dentistry at national universities have come up through their own faculties of medicine or dentistry.
10. *Educational Standards in Japan* (Ministry of Education, Tokyo, 1970).
11. *Reviews of National Policies for Education, Japan* (Organization for Economic Cooperation and Development, Paris, 1971).
12. *Basic Guidelines for the Reform of Education* (Ministry of Education, Tokyo, 1972).
13. A recent book by Michio Nagai, *Higher Education in Japan: Its Take-off and Crash* (Univ. of Tokyo Press, Tokyo, 1971) provides an historical perspective on Japanese higher education with particular emphasis on its role in serving Japanese national needs. The book summarizes much of the current ferment and suggestions for change being considered by various academic groups.

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