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# EDITORIAL

## Science Education in Japan

Japan has reached an important turning point. After World War II, the miracle of Japan's economic growth was achieved through technological innovation and a cheap, well-trained labor force. This innovation, however, was based on introducing basic technologies or concepts from the United States or Europe and improving them. The economic success of this "catch-up" approach ended about a decade ago because of the strength of the Japanese yen, an increase in labor costs, and the growth of other countries in East and Southeast Asia. To achieve further economic development, Japan must develop breakthrough technologies that promise more benefits. This change is not easy, however, because all sectors of Japanese society—including political circles, the administration, industry, and education—have previously been oriented toward catching up economically.

Promotion of basic research is especially important for breakthrough technological innovation. To reach this goal, science and technology policies must be reformed. Science education has an important role to play in this reorientation toward fostering creative scientists. Japan's educational policy used to focus on raising the overall average of all students. This tended to produce excellent economic foot soldiers rather than true leaders, although it was successful in the catch-up phase of economic growth. The ability to cooperate was considered more important than individuality and creativity, and teachers put more effort into giving students technical knowledge than evoking an interest in science.

The Central Council for Education, an advisory body to the Ministry of Education, Science, Sports and Culture (Monbusho), is now discussing the reform of primary and secondary education. Its major goal would be to give more free time to schoolchildren and foster their interest in nature, science, and technology. Cultivation of individuality is another important goal. And in higher education, developing the creativity of gifted students is an important challenge.

Japanese universities have been undergoing radical changes in the past several years. Many are in the process of curricular reform, faculty development, and evaluation of teaching, in accordance with new policies for science education. University faculties, which used to be rather research-oriented, are slowly beginning to pay more attention to teaching. Before the war, graduate schools were small and attended only by academic researchers. Although the situation has slowly been changing in recent decades, the ratio of graduate to undergraduate students in Japan in 1993 (5.5%) was much smaller than the ratio in the United States (15.4%), the United Kingdom (37.2%), or France (18.3%). Over the past several years, Monbusho has encouraged universities to found or expand graduate schools, and the number of students is increasing very rapidly. It is more important, however, to change graduate education in order to respond to the public criticism that Ph.D. students in Japan are too specialized. Broader knowledge is required to open research frontiers and adapt to the rapid progress of science and technology. Finally, the rapid increase in the number of graduate students has necessitated an increase in financial support. Fellowships for doctoral students provided by the Japan Society for the Promotion of Science have expanded year by year, with 2200 recipients in 1996.

In order to promote science in Japan, the Science and Technology Basic Law was enacted in 1995 by the Diet; and in June 1996, the governmental Council for Science and Technology adopted a Basic Plan to achieve the law's goals. The plan calls for a stepwise increase in research grants from the government, increases in support staff and fellowship programs, and the renewal of research facilities. Although one cannot be too optimistic because of budgetary restraints faced by the government, it is hoped that this action plan will strengthen Japan's science and technology infrastructure. More important for the future of science in Japan is education, because educating a generation of capable scientists takes longer than setting up infrastructure, and the quality of science education determines the economic and industrial potential of a society. It is especially crucial for Japan now, as it makes the transition from catching up to joining, both economically and scientifically, the countries at the global forefront.

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