SCIENCE EDUCATION IN TAIWAN — RECENT DEVELOPMENTS AND PLANS

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I am pleased to have this opportunity to present to you a brief history of the development of science education in Taiwan and an account of its present status.

Science, in its specific and narrow sense, is systematized knowledge, as embodied in such subjects as mathematics, physics, chemistry and biology. In the broad sense, science reprecents the incessant exploration of Nature motivated by the search for truth. The object of science education is not confined to imparting the knowledge of science to the student; at the elementary level, it is to arouse the interest of the student in phenomena, natural as well as those surrounding him; at a higher level, it is to introduce him to the beauty of the organized knowledge of different subjects of science; to train him to cultivate the objective and critical attitude in his studies in particular and towards things in general. But science education does not end here; it also has its social aspects. It is also the function of science education to bring up applied scientists to meet the needs of the industries and the society. Science education in the broad sense then extends from the formal parts in the school system to the informal parts of training the citizen with the understanding of the spirit of science.

At the end of the last world war, the whole education system in Taiwan came to a stop. Our government had to rebuild the system from the elementary school to the university. More serious than the shortage of funds was the extreme shortage of teachers in all subjects at every level of the system, and scientists were particularly scarce. To convey some idea of the situation, suffice it to say that even in 1956, the total number of university professors in physics in Taiwan having a doctor's degree was two. The situation was not any better in other basic or applied sciences.

In 1957, I made a proposal to the Government that some effort must be made, despite the financial difficulties confronting our Government, for a long-range development of science. In 1958, the late Dr. Hu Shih, then president of Academia Sinica, succeeded in persuading the Government in setting up the Committee for Long-range Development of Science, with a small budget. This was the predecessor of the present National Science Council, and instituted a program of (1) supporting universities with grants for facilities for teaching, (2) establishing visiting professorships and associate professorships to bring back some Chinese scholars abroad, (3) giving stipends to faculty members on proposed research projects, (4) sending faculty members of universities abroad on furlough. The whole program was on a very small scale, but it was the first Government deed in our science education. Although the magnitude of the job to be done was huge and the budget much too small, the program was extremely important because it sufficiently raised the morale of the people for a beginning to be made of a reconstruction program.

For use in the teaching of science in our high schools, we were very prompt in translating into Chinese the new textbooks on mathematics, physics, chemistry and biology written in the United States soon after the Sputnik. In our universities we began in the early 1960's to build up our faculties. Basic sciences, physics in particular, received a big boost in the esteem of our students from the award of a Nobel Prize to Dr. C. N. Yang and Dr. T. D. Lee in 1957 for their work on the parity non-conservation in the so-called weak interaction between elementary particles. Perhaps it is a bit ironic that the far-less affluent society then was far more conducive to studies in academic subjects.

The next big step in progress in our science education came in 1967. The late President Chiang Kai-Shek decided on a Science Development Program. I was recalled from the United States to head the Committee for Science Development of the National Security Council – an advisory body to the President, and was asked to formulate a 12-year science development plan. The Committee for Long Range Science Development was reorganized to become the present National Science Council. I shall not go into the functions of this new N.S.C.. Suffice it to say that in addition to continuing on all the functions, mentioned before, of its predecessor, the N.S.C. added a department for Science Education. From 1967 to 1973, I was concurrently also the Chairman of the National Science Council.

Now our education system consists of (1) nine years of free (compulsory) education, made up of 6 years of elementary school and 3 years of junior high school, to be followed either by (2) 3 years of senior high school and (3) 4 years of college or university education, and graduate school, *or* by (2v) 3 years of junior vocational school, *or* 5 years

of vocational schools.

A distinctive feature of the Science Development Master Plan we formulated is the inclusion, besides the support of research programs in basic and applied sciences, of science education. Its work in educational matter was, however, in a supporting role to the Ministry of Education and to the Education Bureau of the Taiwan Provincial Government, since university education is under the former and the elementary and high school education is under the latter. Up until 1973 when I was released from the concurrent chairmanship of the N.S.C., I did not have much time and energy to work on education problems. Since then I personally took up these problems.

The first task I took was the organization of a short summer course of two weeks in physics for a group of second year and third year senior high school students selected on their merits from all the school in Taiwan. The idea was suggested to me by Dr. T. D. Lee, the Nobel Laureate of Columbia University, that some of the good students be given a chance to come into contact with some fundamental physics and some very new developments in physics. This Summer Course was tried out for three years. This led me to the realization that there is something rather seriously wrong in the curriculum of our high schools. Among many things, there is the questionable ordering of Biology in the first year, which calls for some knowledge of organic and biochemistry; in the second year, chemistry, which calls for a knowledge of modern physics in the discussion of molecular structure and chemical valence, and finally in the third year, physics.

In 1968, with the translated textbooks from the United States and England, a set of provisional curricula were formed; they were revised and adopted in general use in 1972.

In 1974, the Ministry of Education assigned the Science Education Center of the National Normal University the task of reviewing and improving on the science education in the junior high schools, and in 1976, the task of revising the mathematics curriculum in the senior high schools. The guiding considerations were the following:

(1) our national policy on science education, which is to bring up our next generation of scientists and engineers, for research and the industries,
(2) our social conditions and cultural background,
(3) the individual abilities and interests of the students, and
(4) the needs of our developing educational system and industries.

The following table gives the science curricula for the junior high school in the recently revised form.

1st year	2nd year	3rd year
Math. (3-3)	Math. (4-4)	* Math. (4-4) Earth Sci. (2-2)
	Phys. & Chem. (4-4)	* Phys. & Chem. (4-4) or
Life Sci. (3-3)		* Applied Physics (2-2) or
		* Applied Chemistry (2-2) or
		* Applied Math. (2) instead of Math. (4)

The asterisk indicates "elective".

For the senior high schools, a number of university scientists proposed an entirely newly conceived curriculum for the science subjects, as shown in the following table:

1st year	2nd year	3rd year
Basic math. (5:5) (required of all students)	Math. (4:4) (required of all students)	Math. for sci. major (6:6)
	Basic math. for sci. major (2:2) or	General math. (4:4) or
	Basic math. for non-sci students (2:2)	Math. for business major (6:6)
Basic phys. & chem. (3:3), and	Phys. I (3:3)	Phys. II (3:3)
	Chem. I (3:3)	Chem. II (3:3)
Basic life sci. (3) and	Biology I (3:3)	Biology II (3:3)
	Earth sci. I (3:3)	Earth sci. II (3:3)
Basic earth sci. (3) all required of all students	Student may elect one to three of these courses	Student may elect none to three of these courses. "I" is pre-requisite of "II"

The course "earth sciences" covers astronomy, geology, meteorology and oceanography.

The idea underlying this new curriculum is that by requiring all senior high school students to have "basic mathematics", "basic physics and chemistry", "basic life science" and "basic earth sciences", this will give all students who are going to have a university education a better basic knowledge and training in science and therefore a better liberal education, which will better prepare him for better service to the society in the future.

In 1979, the Ministry of Education formed a Science Education Advisory Committee, and enlarged the Science Education Center of the National Normal University. The Committee is made up of senior educators with background in science and engineering. I serve as the chairman of this committee. Under it, there are 6 subcommittees each made up of 10 to 12 scientists in the six areas of mathematics, physics, chemistry, biology, earth sciences and engineering. The Science Education Center is to supervise the job of writing the new textbooks together with accompanying teacher's manuals for all the courses, trying them out in high schools, revising them, and organizing the teacher courses for the high school teachers. The Advisoring Committee is to formulate and review science education policies and to oversee the projects undertaken at the Science Education Center.

In 1984, the above new program together with the new accompanying textbooks have been put into actual use in the whole education system in Taiwan.

Concluding remarks

I have tried to present a brief sketch of the history and recent development in our endeavor to build up our science education. The whole process consists of some initial provisional programs, followed by some reviews of the existing conditions in our country and a reformulation of our policies and programs. Thus we have completely overhauled our science curricula in the junior and senior high school, and have rewritten all the textbooks and teacher's manuals. We are extending this program to the vocational school system at the present.

We are aware that science education does not aim at providing technology to the economic development of the country alone; it is inseparable from its relation to the other culture – humanities – in the society. Thus our Science Education Program will be a continuing one, consisting on a continual unfolding of deliberations and explorations, followed by a continual updating of the various projects as mentioned in this report.