SCIENCE EDUCATION PROGRAM IN THE REPUBLIC OF CHINA

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I feel honored and pleased to have the opportunity to present to you, our distinguished guests, a brief account of the recent program in the development of science education in Taiwan. Perhaps you will allow me to begin with a few introductory remarks for the purpose of our orientation.

It is generally agreed that in the last decade Taiwan has made considerable progress in economic developments, and it is also generally believed that the economic successes are in large measure due to (i) the social stability as a result of the land reform program carried out in the early 50's, (ii) the policy of free-economy of the Government, (iii) the policy of building up our agriculture and light industries before attempting heavy industries, and (iv) the enterprising quality of the people. But the important contribution made by our education program may not have been so widely appreciated.

Even before 1967 when our compulsory education of six years of elementary school was extended to nine years (six years of elementary school and three years of junior high school), over 90 percent of school-age children attended school. After 1967, this percentage has reached above 99. Then a series of programs were instituted, on education in general and science education in particular. In 1967, under our late President Chiang Kai-Shek, a broad program of science development was started, which, in addition to the basic, applied and social science, covers also science education at all levels, namely, high school, college and advanced, graduate. I shall confine my report to the science education part of our many programs.

The conditions leading us to undertake a reexamination of our whole science education system were the following. We found that the curricula of our science teaching in the primary, junior high and senior high schools were not the results of a well-planned study on a well-considered policy; rather they were the product of independent patchwork over a period of years with no clearly coherent objectives. The textbooks on each subject, say, mathematics, in the various grades came from different independent sources with no attention to continuity, and the various subjects were arranged into a pattern for the various grades with not much regard for relative correlations among the subjects.

To make this last point clearer, take the existing curricula for the senior high school. In the 1st year is taught biology which makes use of some knowledge of organic chemistry (or, biochemistry, in connection with such things as DNA, RNA, etc.). Chemistry, however, is taught in the 2nd year, which includes such topics as atomic structure and chemical bond which the student cannot really digest but can only memorize. Finally, physics is taught in the 3rd year of the senior high school.

The difficulty here cannot be remedied by merely reversing the sequence of these three subjects, because there is the question of the relative difficulties of these three subjects from the point of view of the nature and the sophistication of the basic concepts involved. There is also the question of the availability of certain mathematical preparation at the time physics is taught.

Thus the problem of formulating a curriculum for the science subjects in the education system calls for both a deep and an extensive study of the best arrangement of the various science subjects over the six junior-senior high school years. On top of this is the wish to provide for flexibilities for different junior-high students who plan, or do not plan, to continue on to the senior high school. More of the junior-high graduates will go to the various vocational (senior-high) schools than to the senior-high for college education. Thus we have the problem of organizing the science curricula for the vocational schools too.

We have worked on such curricula, but we have also to prepare the textbooks to go with the proposed curricula, for the curricula are only the framework for the texts which form the substance.

These considerations define the nature and the scope of our Science Education Program which I shall briefly outline in the following.

1. Science education in elementary schools

A project was started by the Ministry of Education in 1970. A committee on science curricula was formed, consisting of university professors, school teachers and specialists on education. New textbooks were prepared and tried out in more than 50 schools for an experimental period of six years, and after revisions were made, the textbooks and the curricula were adopted in 1978 throughout the country.

2. Science education in the junior high schools

In 1968, a set of provisional curricula were formed and new textbooks were prepared on the basis of some American and British texts. In 1972, the curricula and texts were revised; the standard adopted then has been followed till the present.

In 1974, the Ministry of Education assigned the Science Education Center of the National Taiwan Normal University the task of reviewing and improving on the science education in junior high schools, and in 1976, the task of revising the mathematics curricula in senior high schools, on considerations of

(1) our national policies on science education,
(2) our social conditions and cultural background,
(3) the conceptual systems and nature of natural sciences and mathematics, and
(4) the individual abilities, interests and needs of the students.

These two tasks followed the following procedures

(1) planning of the curriculum design,
(2) evaluation of the design,
(3) development of the curriculum materials and media,
(4) selection of experimental schools and teachers,
(5) training of in-service teachers and implementation of the first pilot study,
(6) evaluation of the first study,
(7) revision of the experimental textbooks,
(8) training of in-service teachers and the carrying out of the second pilot study,

(9) evaluation of the second study,

(10) the final revision of the curricula.

The following new natural science and math. curricula for junior high schools will be adopted for all schools in the next academic year.

<table>
<tr><th>students \ grade</th><th>1</th><th>2</th><th>3</th></tr>
<tr><td rowspan="3">For students going to senior high schools</td><td rowspan="5">Math. (3 hrs./week, required)</td><td rowspan="2">Math. (4 hrs./week, elective)</td><td>Math. (4-6 hrs./week, elective)</td></tr>
<tr><td>Physices and chemistry (4hrs./week, elective)</td></tr>
<tr><td>Physics and chemistry (4 hrs./week, elective)</td><td>Earth science (12 hrs./week, elective)</td></tr>
<tr><td rowspan="4">For students not continuing formal education</td><td colspan="2">Physical science (physics, chemistry, earth sciences) (2 hrs./week, required)</td></tr>
<tr><td rowspan="3">Life science (biology) (3 hrs./week, required)</td><td colspan="2">Applied math. (2 hrs./week, elective)</td></tr>
<tr><td colspan="2">Applied chemistry (2 hrs./week, elective)</td></tr>
<tr><td colspan="2">Applied physics (2 hrs./week, elective)</td></tr>
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3. Science education in senior high schools – formation of Steering Committee on Science Education

In 1979, the Ministry of Education established a Steering Committee on Science

Education to assist the Ministry in reviewing and formulating policies on science education and in particular, in overseeing the projects being undertaken at the Science Education Center of the National Taiwan Normal University. The Committee is made up of senior educators with background in science and engineering. Under the Committee, there are six advisory committees, of ten or twelve scientists each, in the six areas ot mathematics, physics, chemistry, biology, earth science (covering astronomy, geology, meteorology and oceanography) and engineering.

The Science Education Center has in the last five years carried out the following projects:

(1) The planning of curricula, in math, physics, chemistry, biology and earth science, in the senior high schools, for students intending to take up science and engineering, or humanities and social sciences in universities. The suggested programs are made flexible by the provision of elective subjects. See the tables below.

Grade 1	Grade 2	Grade 3
Basic Math (5;5) (required of all students)	Math. (4;4) (required of all students) Basic Math. General (2;2) (selective) Basic Math. Review (2;2) (selective)	Math for Science Major (6;6) General Math. (4;4) or Math. for Business Major (6;6) (one of these three is required)

Grade 1	Grade 2	Grade 3
Basic Physics and Chemistry (3;3) Basic Life Science (3) Basic Earth Science (3) (all 3 subjects are required of all students)	Physics I (3;3) Chemistry I (3;3) Biology I (3;3) Earth Science I (3;3) (Students may elect one to three of these 4 subjects)	Physics II (3;3) Chemistry II (3;3) Biology II (3;3) Earth Science II (3;3) (Students may elect none to three of these 4 subjects; but "I" is prerequisite for "II".)

The numbers in parentheses indicate the numbers of hours per week; (3) indicates one semester; (3,3), two semesters.

(2) New textbooks have been prepared for all the subjects in the above tables – each written by a group of professors working closely together and reviewed by other professors and high school teachers. All the new textbooks have been tried out, the Grade 1 texts 3 times, the Grade 2 texts twice and Grade 3 texts once, in classes at the Preparatory School of the Ministry of National Defense (for reasons connected with problems of our college entrance system), and repeated revisions are made on the basis of the experience of the teachers and students.

(3) For each of the textbooks in the above curricula, a teacher's manual has been prepared to provide suggestions for emphasis on the proper, logical introductions of various concepts based on empirical knowledge in the natural sciences, as well as background materials of historical interest and for a broader or deeper understanding of the various topics. These teacher's manuals are intended to form an integral part of our science education program by upgrading the proficiency of the teachers.

(4) The flexibility of the curricula provided by the various choices of selective subjects in the above tables is designed to meet the needs of students intending to take up science, engineering, liberal arts, humanities or social sciences in universities.

(5) The new curricula and new textbooks will be introduced into our junior and senior high school system in 1984.

4. Vocational high schools

A project, similar to that described above for the junior and senior high schools, has been started in 1982 for the revision of the basic science curricula and textbooks for the various vocational senior high schools. This project has fallen behind in our program on account of the large varieties of vacational school at present, but is currently in progress.

5. Kindergarten science education

In 1982, the Ministry of Education has started a research program on kindergarten science education. Work is currently in progress.

6. Basic science teaching in universities

Our next project is to reexamine, in view of the new standards of our new curricula for the senior high schools, the substance of the basic science courses such as calculus, general (college) physics, general (college) chemistry, general (college) biology. This will have the effect of a more coherent and effective science program extending from the senior high school to the university, and this will provide in turn a better training in basic science and engineering in our university education.

7. Concluding remarks

In the preceding sections I have tried to present a brief sketch of the various recent projects, in a general Science Education Program in the Republic of China. The overall aim of this program is to review critically the past and the existing conditions in our

educational system and to reformulate our polices and adjust our system on considerations of the changing needs of our society. Up till now, we have overhauled the science curricula and textbooks in our elementary, junior and high schools, and we are working on the vocational schools, and beginning on the university basic-science courses. The program will then be brought back to a more broader and deeper study of the entire science education problem from the point of view of the country as a whole, that is, science education not only in relation to technologies in the economic developments but also in achieving some rapprochement with the other culture – humanities –in our society. Thus our Science Education Program will be a continuing one, consisting of a continued updating of the special projects as described in the present report, and a continual unfolding of deliberations and explorations.