

Achievement and Prospects of Chemical Education in Taiwan, R.O.C.

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It is my honor and pleasure to have the chance to present to you a brief account of the recent program in the development of chemical education in Taiwan, Free China.

There were two remarkable achievements of my country in the past thirty years. One was the miraculous economic accomplishment, the other was the progress of education. These two achievement were interlinked. The development of education resulted in adequate manpower supply for economic construction, on the other hand, economic construction brought wealth to support continuous expansion of education.

Even before 1967 when our compulsory education was extended from six 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.

I would like to confine my report to the science education, especially in chemical education.

Science education in the elementary schools

A project of science curriculum for elementary school was started by the Ministry of Education at the Taiwan Provincial Institute for Elementary School Teacher's In-service Training. Since 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

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throughout the country.

At the primary school level, chemistry is included in the student-centered natural science textbooks, which emphasize scientific knowledge, scientific processes and scientific attitudes. We have chosen activity centered units such as: fruit juice, pop corns, bubbles and ballons, colored solutions, cane sugar, mystery powders, two gases, and steel wood etc., which have shown to increase student's interest.

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 1984.

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. The study and development committee of chemical education was organized. In considerations of (1) the national long and short-range need, (2) modern and traditional cultural characteristics, (3) the nature of science and its characteristics, (4) the student's physiological and psychological maturation, a new program was designed for chemistry.

The study program employed the following procedures:

- (1) comparing the curricula and teaching materials of various countries,
- (2) establishing a new model for science courses,
- (3) designing the curriculum,
- (4) authoring textbooks and teacher's guides,
- (5) in-service training of experimental teachers,
- (6) first experimental teaching in schools,
- (7) first revision of textbooks and teacher's guides,
- (8) second experimental teaching in schools,
- (9) second revision of textbooks and teacher's guides,
- (10) in-service training of all science teachers.

At the junior high school level, chemistry and physics are integrated into physical science. Teachers' explanations of material and students' inquiry are both emphasized.

The contents of physical science are simplified. The main purpose of this course is to recognize the relationships between the environment and the human life.

The topics of chemistry in old textbooks such as periodic table, hydrogen chloride and chemical equations, heat effect on chemical reaction, electrolysis, reaction rate, reversible reaction, and organic compounds have been deleted, and the topics such as the chemistry of clothes, foods, and housing has been added in the new texts.

The following new natural science curricula (Table 1) for junior high schools was adopted for all schools in the academic year of 1984.

Table 1. Course Design of Science Curricula for Junior High School

Grade 1	Grade 2	Grade 3
Life Science (3, 3) (required)	Physical Science (4, 4) (required)	Physical Science* (4, 4) Earth Science* (2, 2) (elective) Practical Physics** (2, 2) (elective) Practical Chemistry** (2, 2) (elective)

* For students going to senior high school

** For students not continuing formal education

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

For those who are not intending to continue formal education, the texts "Practical Chemistry" and "Practical Physics" are prepared for them in the third year.

Science education in the senior high schools

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 comprises eleven famous scholars and scientists under whose recommendation a total of 62 advisory committee members with specialties in mathematics, physics, chemistry, biology, earth science and engineering have been appointed. In order to establish the planning and to evaluate the production of the Center effectively, an advisory subcommittee has been formed, comprising 12 members with each two of whom were elected from the groups of six fields as both liaison and planning persons.

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

- (1) The planning of curricula, in math, physics, chemistry, biology and earth science

of the senior high schools, for students intending to take up science and engineering, or humanities and social sciences in universities.

(2) New textbooks have been prepared for all the subjects in Table 2 — 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 twice, in classes at the Preparatory School of 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 guide 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 the development of historical background and for a broader or deeper understanding of the various topics. These teacher's guides are intended to form an integral part of our science education program by upgrading the proficiency of the teachers.

(4) The flexibility of curricula provided by the various choices of selective subjects in Table 2 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 were introduced into our senior high school system in 1984.

Table 2. Courses Design of Science Curricula for Senior High School*

Grade 1	Grade 2	Grade 3
Basic Physics and Chemistry (3; 3)	Physics (3; 3) Chemistry (3; 3)	Physics (3; 3) Chemistry (3; 3)
Basic Life Science (3)	Biology (3; 3) Earth Science (3; 3)	Biology (3; 3) Earth Science (3; 3)
Basic Earth Science (3)		
(all subjects are required of all students)	(Students may elect none to three of these 4 subjects)	(Students may elect none to three of these 4 subjects)

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

Texts "Basic Physics and Chemistry" (two volumes) are prepared for the first year of the senior high school. Rigorous chemistry training begins in the second year of the

senior high. Four volumes of "Chemistry" have been prepared. The course can be elective for the 2nd and/or 3rd grade in the senior high school career depending on the students' attitude and ability. The contents of new chemistry textbook are relevant to human's life. We choose some units such as material science and livelihood — food, clothes, housing, transportation, industry and environment. They are more attractive and helpful to students than previous editions.

Features of the new textbooks are stated below:

- (1) The new textbooks are designed to meet our nation's needs.
- (2) The new textbooks emphasize the application of science to daily life rather than on abstract theories.
- (3) SI units are used through out the text. The nomenclatures of compounds comply with the IUPAC convention.
- (4) The text is divided into four volumes. The first volume covers air, water, and water solutions. The second volume covers chemical reactions, acid, base, oxidation-reduction. The third volume covers atoms, molecules and inorganic compounds. The forth volume covers organic compounds and polymers. To each textbook, there is a teacher's guide, which covers far more materials than the textbook.
- (5) Comparing with the old text, the new text puts less emphasis on theories, and contains more materials about atmosphere, water, petroleum chemistry, properties, uses, production of inorganic compounds. On the other hand, materials on nuclear chemistry and biochemistry were reduced.

Conclusion

Of course, science education is stressed in both primary and secondary schools partly for the purpose of training top scientists and technologists. Most primarily, it serves as to consolidate scientific literacy for all of our people, encouraging each modern citizen to acquire an accurate conceptual hierarchy in science and enabling him to possess proper scientific attitudes toward his daily difficulties as well as scientific process skills to solve his problems. It is hopeful that chemical education can be used as one of the preferred ways of preventing from the existence of an unharmonious society. Especially, the by-product of scientific and technological developments brings us a energy crisis, environmental pollution, undermining human nature, and increasing greediness. Taking our 'Three Principles' into account, our science education must place its emphasis on the enhancement of human value to ensure the living of our subsequent generations, the maintainance of human dignity to highlight human rights, as well as the improvement of people's wellbeing to strengthen our harmonious and happy society.

Abstract

Since 1970, a study program of science courses for primary school (1970), junior high school (1974) and senior high school (1978) was sponsored by the Ministry of Education and local governments. This program involved the efforts of 150 professors and 100 school teachers, and spent 100 million Taiwan dollars.

The study program employed the following procedures:

1. comparison study of curricula and teaching materials of various countries
2. establishment of a new model for science courses
3. design of the curriculum
4. authoring of textbooks and teacher's guides
5. in-service training of experimental teachers
6. first experimental teaching in schools
7. first revision of textbooks and teacher's guides
8. second experimental teaching in schools
9. second revision of textbooks and teacher's guides
10. in-service training of all science teachers

The program has functioned smoothly. The newly-authored textbooks for primary schools, initiated in 1978 and for secondary schools initiated in 1984 have proven to be more attractive and helpful to students than previous editions.

At the primary school level, chemistry is concluded in the student-centered natural science textbooks, which emphasize scientific knowledge, scientific processes and scientific attitudes. At the junior high school level, chemistry and physics were integrated into physical science. Teacher' explanations of material and students' inquiry are both emphasized. In the senior high school, chemistry is divided into two levels: level I is required physical science. The contents are related to everyday life. The purpose of this course is to promote citizens' scientific literacy. Level II is elective chemistry which is preparatory for university study.