ChemCom After a Decade: A Look Backward and Forward*

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Introduction and Background

Science education at the secondary level (grades 10-12) in the United States of America is very different than in most other countries. During pre-secondary and secondary (high) school in most countries, students are taught biology, chemistry, and physics principles together for several years. This continuum approach appropriately builds on basic principles learned previously, and also provides opportunities for students to make connections and discover relationships among the three sciences. In the USA, however, such is not the case; the subjects are taught independent of each other. Students in the USA are generally offered one year of biology in high school (grade 10), one year of chemistry, usually in grade 11, and then one year of physics in grade 12. The USA does not have a standardized national curriculum or national examinations for these courses. In most cases, what is taught is entirely up to the individual teacher.

Not all USA students take all three of these sciences; only a relatively small percentage of them do. Nationally, the percentages of students enrolled in these science courses are typically: biology –more than 95 per cent; chemistry– just under 50 per cent; and physics– about 20 per cent.

Because of this uneven involvement with the three basic natural sciences, it is not surprising that only about 7 per cent of Americans who are high school graduates can be described as being scientifically literate. These are citizens who keep up with scientific developments, who have a working scientific vocabulary, and who understand how science affects their daily lives. More than four out of five Americans are not attentive to science in any form. Fewer than half understand that electrons are smaller than atoms, and only about one in ten understands the term "molecule".

The Need For Chemistry in the Community (CHEMCOM)

The high school chemistry course is the only opportunity for most students to study chemistry formally in the USA education system, and only about half do so. Among those who take high school chemistry are many who will go on to attend universities. However, fewer that 15 per cent of high school chemistry students will major in a science or technical field at university. Thus, the high school chemistry course will be their only exposure to chemistry for the large majority of high school chemistry students.

Following the launching of Sputnik in 1957, extensive curricular developments occurred in the USA in an attempt for high schools to better prepare students for university majors in natural sciences and engineering. In chemistry, the Chemical Bond Approach and CHEM Study projects were particularly noteworthy. Throughout the 1960s into the 1980s CHEM Study became the model for most high school chemistry courses. The CHEM Study course was physical chemistry based, and increasingly consisted of physical chemical principles normally taught in the first year of university chemistry. Thus, high school chemistry in the USA became a principles-based course, with little descriptive chemistry and few direct applications of chemistry to students' everyday lives. Topics in organic chemistry, industrial chemistry, nuclear chemistry, and biochemistry were not taught. This was the case in spite of the fact that the overwhelming percentage of chemistry students would not take another chemistry course.

Thus, up to 90 per cent of USA high school chemistry students were taught a course that failed to teach chemical principles applied to "real world" situations, those of higher interest to high school chemistry students. In 1981, the American Chemical Society, through its High School Chemistry Office, then directed by Sylvia Ware, sought to address this inadequacy. Sylvia Ware's creative idea was to develop several units based on teaching chemistry principles within the context of major societal-technological issues affecting people's lives, thus the name Chemistry in the Community. ChemCom's unique approach:

- Places chemistry in a societal context;
- Uses chemistry to understand societal-technological problems;
- Introduces data analysis and scientific inquiry;
- Has students develop and practice decision-making skills.
- Using this breakthrough approach, the chemical principles are taught on a "need-to-know" basis, a basis that:
- Introduces students to community or social issues involving chemical components;
- Leads students to realize that they need to learn additional chemistry principles to deal with the issues intelligently;
- Then develops the relevant chemistry and shows its connection to the issues;

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- Applies the chemical knowledge in decision-making activities related to the scientific-technological aspects of the issues.

Another unique aspect of ChemCom's development was that the units were written by joint teams of high school chemistry teachers in conjunction with university chemistry professors, working as close colleagues at several sites. In contrast, CHEM Study and the Chemical Bond Approach had been written by university professors. Many of ChemCom's special features came from suggestions made by the high school teachers. Dr. Henry Heikkinen, a former high school chemistry teacher and then a chemistry professor at the University of Maryland, was named Editor in Chief of the project.

Chemistry in the Community

Funding for the ChemCom project was obtained from the National Science Foundation in 1981. From 1982 to 1985, units were drafted, field tested in the classrooms of the high school teachers who co-authored them, and were revised based on student and teacher feedback. By 1985, eight units were ready to be pilot tested nationally by 2,900 students in urban and rural high schools of varying size, complexity, and ethnic mix. The eight units were:

- Supplying Our Water Needs
- Conserving Chemical Resources
- Petroleum: To Build or to Burn?
- Understanding Foods
- Nuclear Chemistry in Our World
- Chemistry, Air, and Climate
- Chemistry and Health
- The Chemical Industry: Promise and Challenge

The eight units contain chemistry content, laboratory activities, societal-technological issues, and decision-making activities. Each unit begins with a statement of the issue or problem that serves as the theme for the unit. For example, the first unit starts with a newspaper announcement of a fish kill in a community for which fishing is important to the local economy– What killed the fish? Every unit concludes with an activity called Putting It All Together in which students consolidate chemical principles learned in the unit in order to address the issue posed at the beginning of the unit. The Putting It All Together at the end of the first unit is a Town Council meeting in which students role play as representatives of various scientific, commercial, and citizens groups affected by the fish kill to assess reasons and responsibility for the fish kill. Each unit also contains two other types of decision-making activities: Chem Quandry– brief activities to stimulate and challenge; and You Decide– activities similar in scope and design to a chemistry laboratory activity, but focused on processing information involved in a decision-making task. You Decides often involve small group work activity and class discussion. Each unit also contains laboratory activities, about six activities per unit.

Based on very detailed feedback from the 1985 pilot test teachers, the eight units were revised by Henry Heikkinen, and a second national trial of them was conducted with 6,000 students during the 1986-87 school year. Final changes were then made. The first edition of ChemCom was published in 1988. Because the ChemCom approach is different than the traditional one to teaching chemistry, a national program of highly successful in-service workshops was begun in 1988 for teachers wanting to use ChemCom. The workshops continue to be held; almost 1200 teachers have attended them since 1988.

In addition to the workshops, several auxiliary items are available to ChemCom teachers. A voluminous Teacher's Guide provides valuable pedagogical information and detailed unit-by-unit suggestions for class and laboratory work. Chemunity News, a newsletter published five times a year by the ACS, contains a ChemCom section. And a ChemCom examination has been developed by the ACS Examinations Institute.

The second edition of the ChemCom textbook was published in 1992; the third edition was published in 1997. The third edition of ChemCom retains the same general philosophy and need-to-know approach of the previous editions, and includes the decision-making and laboratory activities. Laboratory activities, however, are now on the microscale level for safety and cost reduction. The larger-scale laboratory versions of the experiments are still available in the Teacher's Guide. The Putting It All Togethers have been changed for each unit, except the first one. Some of the units have been refocused. The Nuclear unit now emphasizes everyday applications of nuclear technologies rather than focusing on nuclear weapons; the Health unit has changed from a health focus to one involving choices and risk analysis, hence the new unit title, Personal Chemistry and Choices. Several new laboratory activities have been added including Isopropanol Distillation, Chromatography of Food Dyes, Burning a Peanut, and Evaluating Sunscreens.

ChemCom has moved from its beginnings as an alternative course different than the traditional chemistry course to become a curriculum widely accepted and appropriate for the majority of USA high school chemistry students. This is evident from the number of students who have been taught ChemCom. To date, more than 415,000 ChemCom textbooks have been sold.

Additional information about ChemCom can be obtained from the High School Office of the American Chemical Society, 1155 Sixteenth St. NW, Washington, DC, USA 20036.