EUROPE: INTRODUCING CHEMICAL CONCEPTS USING ENVIRONMENT CONTEXTS

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Summary

Chemical concepts, at an appropriate level, can be introduced in the context of environmental concerns. Examples in this article include courses at junior secondary, senior secondary, and university levels.

1. Introduction

This article will give illustrations in the way chemistry courses can be enlivened. The examples will take readers from junior secondary (11 years old) to senior undergraduate courses, and all have been developed in the Department of Chemistry at the University of York.

In the late 1970s, some new courses in our university chemistry degree program were introduced to illustrate the applications of chemistry in society. These courses included industrial economics, technology, natural resources, and the environment. All the courses are taught by chemists in the department; all use chemistry in illustrating the various issues. Thus in the courses on economics, the examples are about the chemical

industry; in courses on natural resources, geochemical principles are stressed; in courses on the environment, it is the chemistry of the atmosphere that plays a lead role.

The examples used in these courses became absorbed in other chemistry courses, for what better illustrations of spectroscopy, thermodynamics, and kinetics are there than in the chemistry of the troposphere and stratosphere?

Unwittingly, through trial and error, we were discovering for ourselves what every school teacher knows. Our course must:

- motivate and interest students,
- allow students to bring to it their knowledge and understanding, and
- allow students to develop their understanding of the chemical concepts.

The Department of Chemistry is extremely interested in developing close relationships with teachers in schools for it enables us to keep abreast of the many changes occurring in secondary education and, in turn, to tailor the courses accordingly. This interest, which began by giving in-service courses to chemistry teachers, has developed markedly since the early 1980s and is now formalized under the titles of the University of York Science Education Group (UYSEG) and the Chemical Industry Education Centre. The next sections are devoted to three courses that have been developed for schools.

These are the Salters Chemistry Project, the Salters Science Project, and the Salters Advanced Chemistry Project. The projects have several things in common: the name Salters, a charitable organization that has partly funded the work; the method used to develop the materials; and the development process, which included teams of university and school teachers, science educators, and industrialists who have worked with two national examination boards. Some 250 000 students have studied, or are studying, for national examinations using the materials produced by the projects.

2. Salters Chemistry and Science Projects

2.1. The Projects

Too often teachers complain about school science courses: many concepts appear to students to be both difficult and irrelevant. Science education in few countries can escape these strictures. The challenge to all curriculum developers is to provide a curriculum that captures interest while catering to the educational needs of students.

In science curricula, various goals must be remembered. These include the need to:

- Address the needs of students who wish to pursue the subject at a higher level
- Inspire students to think about science and technology in terms of their future careers
- Educate all the others, the large majority, to enable them to work and live enjoyable and effective lives in a society increasingly dominated by science and technology

Many curricula are devised by defining what is expected of students at the end of the course. However, for these curricula, only the following three criteria were considered in the first stages of planning:

(a) *Relate the course material to life experience*. Consider what students will bring to the course at that age, and base the content of the course on something from their lives that they have experienced either first-hand or through the media.

(b) *Link concepts to context.* Introduce the underlying science concepts only when they are needed to help the students understand the work. Thus, the concepts are linked to a context that students perceive as important, presented in a series of units. The following pairs of concepts and contexts are examples in the Salters chemistry and Salters science courses that involve the environment:

(i) Link the effect of heat on substances (thermal decomposition) to the pyrolysis of plastics used in a new recycling process.
(ii) Link the introduction of symbols, a chemist's international language, to the Hazchem code, used internationally for the safe transport of chemicals.
(iii) Link ideas about collection and correlation of data linking fluoridation of water and tooth decay in children.

(c) *Encourage active learning and exploration.* A more detailed example is given later in this article. This approach has been graphically described as curriculum development through the looking glass. The work must involve students in a wide range of activities in which they are encouraged to learn, rather than simply being taught.

2.2. Interactive Study

The course could be given by teachers in a series of lectures and demonstrations, but this is not the Salters way. We use a variety of learning strategies and encourage participation in many types of activities.

2.2.1. Learning Strategies

The students are kept involved throughout the course using a wide range of cooperative learning strategies:

- Student practical work
- Small group discussions
- Creative writing and reporting
- Role-playing exercises for discussing value-related issues
- Exploration of various other decision-making activities

2.2.2. Activities

In all this, recent research influenced the development, in particular constructivist theories and the role of student talk in learning. Opportunities were sought for student-student discussions in contexts that require students to participate in a broad variety of activities. Students must be encouraged to get involved and to:

- Articulate their understanding of the concepts
- Plan investigations
- Discuss implication of data
- Consider social and economic issues

Some of the discussions lead to presentations that are meant to be delivered by students to the whole class, either orally or with posters. The discussions may also lead to some creative writing. The teachers' role is to provide a variety of opportunities for students to learn about the science as much as to teach students directly.

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Biographical Sketch

Professor David Waddington was professor of chemical education at the University of York from 1978 to 2002, and head of the Department of Chemistry from 1983 to 1992. He is now emeritus professor, as well as visiting professor, IPN, University of Kiel, Germany, and guest professor, Mendeleev University, Moscow, Russia. Professor Waddington was founding director of the University of York Science Education Group and the Chemical Industry Education Centre; chairman of the Committee of Teaching of Chemistry, International Union of Pure and Applied Chemistry (1981–1985); and chairman of the Committee of Teaching of Science, International Council of Scientific Union (1989–1994). He received the Nyholm medal (Royal Society of Chemistry) in 1985, the Brasted Award (American Chemical Society) in 1988, and the Brazilian Grand Cross, National Order of Scientific Merit, in 1997. He is the author and editor of many books and papers in chemistry and chemical education.