

George M. Bodner
and J. Dudley Herron
Purdue University
West Lafayette, IN 47907

Impressions of the McMaster Conference on New Directions in the Chemistry Curriculum

The launch of the first Sputnik on October 4, 1957, generated a shock wave which ultimately led to a revolution in the introductory courses in chemistry. Recently, there has been indication of a resistance to certain aspects of the new curricula which suggests that the time for revision may have arrived once more. In response to this ground-swell movement, roughly one hundred chemists and chemical educators convened at McMaster University, the week of June 19–23, 1978, for an international conference on New Directions in the Chemical Curriculum.

Conference Goals

The organizing committee proposed a conference on the content of high school and introductory college and university chemistry courses, whose goal was the development of an outline for a new curriculum which placed a greater and more appropriate emphasis on descriptive chemistry. It was argued that students need to be introduced to chemistry as a study of the properties and reactions of substances rather than as a collection of abstract principles. The conference objectives were

- (1) To identify the problems associated with the curricula of introductory chemistry courses
- (2) To define the aims and overall objectives of introductory chemistry courses
- (3) To identify a suitable body of descriptive material and relevant applications which could form the basis of a typical, more balanced introductory chemistry course
- (4) To develop an outline curriculum which integrates appropriate principles with the descriptive material, and
- (5) To initiate an ongoing effort to promote the role of descriptive chemistry in introductory courses.

It was evident that the participants were drawn together by the belief that, "the uncomprehending learning of facts has been replaced largely by the uncomprehending learning of theories."¹ Furthermore it was apparent that the participants shared a belief that certain topics currently included in the curriculum are too complex to be treated adequately in the available time. Attempts to simplify this material frequently lead to arguments or analogies which are, at best, misleading and, at worst, incorrect.

What the Conference Produced

The inclusion of additional material on descriptive chemistry obviously requires the removal of topics that are covered presently. Unfortunately, agreement could not be reached as to which of our "sacred cows" to sacrifice. There seemed to be some agreement that most of the quantum mechanics and thermodynamics currently taught at the high school level could be removed. Few would argue that atomic orbitals should be removed from the introductory course. However, hybrid atomic orbitals, molecular orbitals, the shapes of atomic orbitals, and, for some, electronic configurations are of less importance. Similarly, thermochemistry in the form of enthalpies of reaction was deemed suitable for inclusion, but the mechanical interconversion of heat and work, the concepts of entropy and free energy, and the distinction between reversible and irreversible reactions were found to be increasingly difficult to teach if not less important.

There was similar disagreement as to what constitutes descriptive chemistry. To some, descriptive chemistry means the discussion of the occurrence, properties, synthesis, and

reaction of chemical compounds. To others it includes discussions of technological and industrial applications of chemistry. Others argue that descriptive chemistry should not be restricted to examples drawn from inorganic chemistry but must include healthy doses of both organic chemistry and biochemistry. Regardless of the controversy over the definition of descriptive chemistry, consensus was apparent that chemistry is an experimental science in which descriptive material plays an essential role. It was argued that the introduction of sophisticated theory as the basis for the study of factual material misrepresents the science.

Prototypes Already in Place

During the course of this conference, a significant amount of time was devoted to the study of projects already underway to implement the goals of the conference. Particular attention was paid to the secondary school syllabus developed by the Australian Academy of Sciences,² and the ALCHEM or Alberta Chemistry materials developed by high school teachers in Alberta, Canada.³

The Australian syllabus resulted from (1) dissatisfaction with the performance of students who had studied abstract concepts such as free energy and atomic orbitals but could not describe the properties of the simplest chemical substances, (2) dissatisfaction with the decline in the popularity of chemistry in the high schools, (3) concern that existing courses may require a level of intellectual maturity greater than one can reasonably expect, and (4) realization that courses which served only the top students in each class were not going to alleviate the negative attitude toward chemistry. The Alberta curriculum consists of two half-year courses taught in grades 10 and 11, and a full-year course taught in grade 12. Approximately two-thirds of each course is devoted to core concepts covered by all instructors, the remaining time is devoted to one or more electives, including locally developed material.

Although developed independently, the Australian and Canadian curricula bear many similarities. Both curricula retain the experimental approach to chemistry that Chem Study engendered. They reject, however, the physical orientation of Chem Study and question the limited appeal of this curriculum. Both curricula attempt to broaden the population exposed to at least minimal amounts of chemical training. They are in agreement on the importance of factual, descriptive chemistry, and they share an understanding of the importance of technological and industrial applications of chemistry, particularly the effect of chemistry on the student's day-to-day life. Finally, they agree fairly well on the topics in the present curriculum which should be de-emphasized to

¹ Gillespie, R. J., *Chem. in Can.*, 28, (1976).

² Additional information on the Australian curriculum can be obtained by contacting D. W. Watts, Department of Chemistry, University of Western Australia, Nedlands, Western Australia 6009. Copies of the draft syllabus can be obtained for \$2.50 by contacting the authors at Purdue University.

³ Copies of the ALCHEM material can be obtained from the publisher, J. M. LeBel Enterprises, 10372 60th Avenue, Edmonton, Alberta T6H 1G9. Additional information can be obtained from Frank Jenkins, Queen Elizabeth Composite High School, 9425 132nd Avenue, Edmonton, Alberta T5E 0Y4.

allow for expansion of the treatment of descriptive chem-

istry.

Concluding Thoughts

The authors would cite the following as accomplishments of this conference:

(1) The participants were reassured that they are not alone in their belief that descriptive chemistry must return to the introductory course in chemistry.

(2) Curricula described at this conference provided useful examples of how descriptive chemistry might be reintroduced into the beginning course without necessarily returning to the outdated curricula of the 50's.

(3) Although there is not total agreement, it did appear that there are common beliefs concerning the concepts which might be de-emphasized to make room for descriptive material.

(4) At least two approaches to descriptive chemistry are apparent. One can utilize descriptive examples to illustrate chemical principles,

principles can be found, each building upon the other.

or introduce principles on a framework based on factual material. Either approach represents an intermediate path between the extremes of the last few decades.

(5) It became apparent that problems still exist. In particular, we teach what we are taught, and many chemical educators are now alumni of physically-oriented curricula. They, therefore, need assistance in the preparation of descriptive-oriented courses.

It is evident that this conference was merely the first step toward the goals the participants feel must be achieved. No conference can develop a new curriculum in the space of a week. However, the participants can now return to their home institutions to begin the laborious task of adapting what was learned to their own institution's problems. It is in this sense that many of us feel optimistic about the results of the McMaster conference. It is not the solution to our problems, but it is a first step toward a more balanced introductory course in which both descriptive chemistry and chemical principles can be found, each building upon the other.