Survival of the High School Chemistry Lab

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As we approach the 21st century, will we witness the demise of the high school chemistry laboratory? Is there a way to modify the safety strictures presently strangling high school lab programs? Are national testing programs responsible for the decline of the laboratory? Can we assess the rewards of the laboratory experience so as to justify the high cost of the necessary lab time, equipment, and supplies?

A group of 22 high school chemistry teachers from 16 states and the District of Columbia met for a two-week period in the Lawrence Hall of Science, University of California, Berkeley, this past summer for a Laboratory Leadership Workshop under the auspices of the Institute for Chemical Education, ICE, to address some of these questions. The main thrust of the workshop centered around the role and the assessment of the laboratory program in high school chemistry.

The Role of the High School Laboratory

Chemistry is an experimental science. Therefore, chemistry without the laboratory is not chemistry at all. The old Chinese saying puts the laboratory into its proper perspective:

I hear, and I forget.
I see, and I remember.
I do, and I understand.

Doing is essential to chemistry. Teaching chemistry without lab is like teaching art without paint and canvas or like learning to ride a bicycle by reading the owner's manual.

The laboratory is the heart of the chemistry course. Without the heart, our students become problem-solving robots. Laboratory work is worth the investment of both time and money from the first day of the course to the last.

Safety Strictures

Recently, a number of states have adopted safety requirements that are counterproductive for high school labs. Benzene is no longer allowed in the lab; therefore, future citizens now taking chemistry will be unable to identify the odor of benzene in the gasoline they buy or in industrial-strength cleaning solutions used routinely by the janitorial staff. Hydrogen sulfide gas, once generated profusely by budding chemists, is now considered too toxic to generate without fume hoods. As a result chemistry teachers lacking fume hoods omit labs that produce small amounts of this gas. Consequently, a generation of chemistry students with untrained noses fails to identify and avoid nauseating fumes containing hydrogen sulfide and other gases pouring from many automobile exhaust pipes and from decaying sewage. While we do not advocate a return to the copious production of the past, we do advocate a one-time, carefully controlled demonstration. In our opinion, the odor of hydrogen sulfide is a component of chemical literacy.

Another traditional experiment, the melting temperature of paradichlorobenzene, generates fumes considered unsafe. However, these fumes emanate from "deodorized" bathrooms, both public and private, with no educated nose to recognize the danger. This chemical is sold over the counter for home use as a moth repellent.

Certain states are outlawing the use of nitrates in the laboratory, including even minute amounts of silver nitrate, because nitrates are oxidants and can be made into explosives. Yet nitrates may be obtained from the local garden center. Methyl salicylate, another toxic compound, may be purchased in many forms for use in the home.

This Journal and other publications have fostered the paucity of lab options for high school chemistry through their columns on safety. Safe alternatives are needed for labs deleted by safety restrictions; however, such alternatives cannot be suggested in print due to the litigious nature of our society. In many cases we demand that chemistry lab safety exceed that of the home. When did you last wear goggles to boil an egg?

Tort liability in our country has reached unreasonable levels. As a result, our students are denied lab experiences routine to students in other countries. The disparity in lab experience is reflected by our mediocre scores on the laboratory section of the International Chemistry Olympiad.

National Testing Programs

Many in our group feel that National Examinations, such as The College Board's Advanced Placement and ACS testing programs, have, by failing to assess laboratory learning, caused a decrease in the amount of time spent in the laboratory. Some AP instructors find the lecture mode a more efficient way of transferring knowledge and omit laboratory work. Many AP chemistry teachers defer all laboratory work until after the AP examination in mid-May. There are a number of first-year chemistry students who never enter the laboratory. We find these situations appalling. When you delete lab, only oratory remains. Chemistry is not oratory.

While we concede that doing experiments is not as efficient as the lecture method for preparing for present-day examinations, we contend that experimentation is the most effective method for learning chemistry. After all, the chemistry textbook itself is but a compendium of laboratory notebooks from the past. Doing lab is fun. This fact is the primary factor in motivating students to choose chemistry as a career.

Assessing the Laboratory

Few studies have effectively assessed the value of the laboratory. Our group members are convinced that the lab is essential, not just as a tool to learn chemistry, but also as a method to learn life skills. We are designing assessment

instruments to use this year to assess our lab students and programs. It is our hope that such instruments will ultimately result in validation of the necessity of the laboratory to chemistry so that adminstrators will provide the necessary funds for a laboratory program.

Such validation sends a message to administrators to increase the amount of lab time, to provide equipment and materials needed for lab, and to provide the necessary paraprofessional help to chemistry teachers. Chemistry teachers need paraprofessional assistance with lab and demonstration preparation, and they need time to evaluate experiments and assess lab reports. Teachers with nonexistent assistance and with multiple preparations and extracurricular duties cannot provide an effective and stimulating laboratory experience for their students.

It is the group's opinion that the laboratory is so important to the teaching of chemistry that no obstacle should be left in place. It will take the cooperation of all individuals to restore laboratory to its proper role in the high school chemistry curriculum.