"PRACTICAL WORK IN CHEMISTRY EDUCATION"

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Bassam Z. Shakhashiri
Professor of Chemistry and the William T. Evjue Distinguished Chair for the Wisconsin Idea

Director, Wisconsin Initiative for Science Literacy

Department of Chemistry
University of Wisconsin-Madison

In this presentation I shall comment about the roles of laboratory instruction and of demonstrations in chemistry instruction. Traditionally, chemistry courses at all levels have included instruction in laboratory settings where students follow procedures directing them to mix chemicals, make measurements, analyze data, and draw conclusions. At the elementary, secondary, and early college levels the laboratory work frequently consists of what is generally described as "cook-book" exercises. At the higher levels attention is focused on discovery and the development of technical skills to conduct original research. The goals and desired outcome of practical work are the subject of considerable debate, including inquiry-based approaches and electronic simulation of chemical transformations. Important aspects of the debate center around the value versus cost of any laboratory experience and safety versus hazards of chemicals. Administrators cite these concerns to justify the elimination of laboratory work all together. As laboratory experience is being eliminated from the training of the future workforce, huge investments are simultaneously being made to support laboratory facilities for graduate and industrial research that will require well-trained workers. In order to advance the debate over the importance of laboratory instruction, much scholarly work on the efficacy of this instruction is needed, especially in going beyond the development of technical skills to the influencing the attitudes of chemistry majors as well as of general students toward the nature of science. Learner attitudes can be influenced by watching teachers do experiments in classroom settings. Demonstrations are used to display chemical phenomena and to illustrate chemical principles. Lecture demonstrations help focus students' attention on chemical behavior and properties, and they increase students' awareness and knowledge of chemistry. To approach demonstrations simply as a chance to show off dramatic chemical changes or to impress students with the "magic" of chemistry is to fail to appreciate the opportunity they provide to teach scientific concepts and to learn properties of chemicals. The lecture demonstration should be a process, not a single event. The instructional purposes of the lecture dictate whether a phenomenon is demonstrated or whether a concept is developed and built by a series of experiments. Lecture experiments generally involve more student participation through greater reliance on questions and suggestions from students, such as

"What will happen if you add more of . . .?" Even in a lecture demonstration, however, where the teacher controls the flow of events, the teacher can ask the same sort of "what if" questions and can proceed with further manipulation of the chemical system. In principle and in practice, every lecture demonstration conveys the teacher's attitudes about the experimental basis of chemistry, and through them teachers can motivate their students to conduct further experimentation and lead them to understand the interplay between theory and experiment. Lecture demonstrations should not, of course, be considered a substitute for laboratory experiments. In the lecture hall, students witness chemical changes and scientific apparatus as manipulated by the teacher. In the laboratory, students work directly with chemicals and equipment at their own pace and make their own discoveries.