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Of Special Interest

Report On "Technology and Assessment in Chemistry"

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Students will be able to specify what these scientific tools are used for, when they are and not used, and what assumptions are made in using them.

The workshop "Technology and Assessment in Chemistry" discussed a University of California at Los Angeles based and National Science Foundation funded project that is heavily invested in new instructional technology. Issues related to the convergence of technology and student learning and assessment were examined. The workshop was run by Bob Kozma of the Stanford Research Institute. Kozma first outlined the goals of the UCLA project entitled the "Molecular Science Project" developed by Arlene Russell and Orville Chapman. Unlike other curriculum-reform projects, assessment is an integral part of the innovation. Kozma proceeded to describe his efforts to develop new assessment tools.

"Technology and Assessment in Chemistry" by Bob Kozma was presented at the "Day 2 to 40" workshop symposium held May 10–11, 1997. The two-day event was held in the Willard H. Dow Chemical Sciences laboratory building on the central campus of The University of Michigan in Ann Arbor, Michigan. Each of the articles that comprise this issue was written by one of the group of reporters whom I asked to attend each session to take field notes and then follow up with the session leader and participants afterwards.

—Brian P. Coppola, Proceedings Editor

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The UCLA program is unique in the fact that it is a totally digital curriculum. The program instructional goals listed below were provided to workshop participants in the form of a handout.

Molecular Science Project Instructional Goals

Domain Knowledge: The Concepts, Principles, and Tools of Chemistry

1. Students will demonstrate an understanding of key concepts and principles related to chemical properties, structure, reactivity, and theory.

2. Students will be able to use the tools of modern science, including general productivity tools, such as word processors, spreadsheets, presentation software, and the Internet, as well as scientific tools, such as spectrographic equipment and molecular modeling programs. Students will be able to specify what these scientific tools are used for, when they are and not used, and what assumptions are made in using them. Students will be able to interpret the output of these scientific tools.

Scientific Problem Solving

3. Students will be able to analyze complex, authentic problems and design solutions that involve the application of the key scientific concepts and principles cited above. They will be able to come up with authentic problems of their own.

4. Students will be able to take on the role of scientist-in-charge by making decisions about next steps in the process. They will develop models that account for observations and explain data; they will devise means of testing models, make observations and acquire data from databases and simulated instruments, and modify or reject models that have problems.

5. Students will develop the symbolic analyst’s capacity for abstraction and system thinking. This involves the ability to explain how pieces of a system interlock and interact, to interrelate new knowledge to previously learned knowledge, and to see how the subparts fit together.

6. Students will develop critical-thinking skills. They will be able to analyze, compare, and critique their own work and that of others.

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Communication Skills

7. Students will be able to use the language of science and develop their communication skills. They will be able to write about science, articulate their ideas, and challenge and defend ideas. They will use terms appropriately and precisely. They will be able to understand and express ideas in multiple representations, such as scientific nomenclature, quantitative and mathematical representations, chemical equations, graphs, and structural diagrams. They will be able to use these various representations appropriately and transform a given representation into an equivalent one in another form.

Collaboration Skills

8. They will be able to collaborate with others in doing science. They will be able to work as part of a team, contributing their own ideas and skills and drawing on the ideas and skills of others.

Attitudes

9. Students will improve their attitudes toward science. They will not only increase their enjoyment of science, but they will also improve their scientific attitudes (i.e., their belief in scientifically-based explanations compared to nonscientific belief systems, such as astrology).

Focus then switched to the assessment (see appendix, 31jh1897.pdf) of the above goals; namely, how should teaching and assessment change if students have easy access to technology? Three major components of assessment were examined. If technology is to be used exclusively then (1) tasks and questions that students are asked to perform or answer must reflect the use of technology, (2) responses made by students must be based in the use of technology, and (3) a method for the scoring of responses must be developed. Further discussions centered around the assumptions involved in a coordinated approach to changing assessment. Specifically, if there is going to be successful reform, then assessment must link and coordinate curricular, instructional, and technological development; coordinate and integrate cognitive competence with subject matter knowledge; and, finally, coordinate measurement and scoring. To illustrate all of the above ideas, a sample unit titled “Molecule Exploration,” developed by Pat Wegner at California State University, Fullerton, was distributed.

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The exercise consists of a group of four students analyzing structural data for twelve molecules. Each student is to analyze the spatial arrangement of three molecules and organize and display the data in tables and drawings. The group then pools their data and submits a written report that discusses the trends and patterns in molecules with regard to distances and angles. A sample report was distributed. Workshop participants were asked to complete the task as a student would. Instructional goals of the exercise were to be identified and included organizing data, systematic thinking about chemical structure, individual and collaborative efforts, and the ability to communicate ideas. Finally, using the three assessment components listed above, participants were to determine how technology could change the assessment of the exercise; that is, What assignments could test a student's understanding of trends in molecular structure? How are goals such as student collaboration, group communication, and attitude evaluated? How can group dynamics be created to encourage students to acquire learning skills they do not possess? Calibrated peer evaluation was offered as one solution. Student's would be trained on how to recognize effective writing and collaboration and then use these skills to evaluate fellow group members. Another suggestion involved not grading the answer, but instead grading the process of creating the response. Serious concerns were raised about the ethics of attitude measurement. The session ended with lively discussions addressing all of these issues. Typically, more questions were raised than answered.

Throughout the workshop, many issues were raised concerning the use of technology in the classroom. First of all, What is defined as technology? Will hands on laboratory classes be replaced by computer simulations? Kozma discussed an experiment where students in a laboratory class were fitted with microphones and videotaped. Results indicated that students were overwhelmed by the physical nature of the laboratory; that is, Has the experimental apparatus been assembled properly? Is this chemical dangerous if spilled? etc. Very little, if any, molecular connections were made with the objective of the experiment. In the case of a computerized molecular-modeling laboratory, however, students did talk about molecular representations in the context of the exercise. Some workshop participants argued that because chemistry is an experimental science, students should be aware of the physical nature of the laboratory.

The general responses to the "Technology and Assessment in Chemistry" workshop were positive. The group discussions were universally viewed as beneficial. Many

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participants acknowledged thinking about incorporating the “Molecule Exploration” exercise into their courses. Others found the tabular framework for designing assessment tasks to be useful: placing the learning goals in rows and the three assessment components (task, response, and scoring) in columns. The was a general desire, however, that more concrete examples be included, for instance, assessments that have worked and have been recognized as valid ways to assess new methods of teaching and learning. Also, a discussion of literature results that address the question of whether or not new teaching technologies were accomplishing established classroom goals was desired. Any future symposia should answer these questions as well as give the results from the UCLA reform.