

students in an active learning environment [J. Katz, M. Henry, D. Johnson, "Turning Professors into Teachers", Macmillan (1988); S. Tobias, "They're Not Dumb, They're Different: Stalking the Second Tier", Research Corp., Tucson, AZ, (1990); C. K. Herman, J. Chem. Ed. (1995), 72, 157.] This condition, of course, does not necessarily require computers or advanced technology, but clearly the computer based communication explosion that is now underway provides an excellent base from which to induce better communication from students to the professor, often from the safety and anonymity of a remote connection. It is a continuing irony that students are often more comfortable when their academic shortcomings are witnessed by the inanimate computer rather than the human professor. Scores of projects are ongoing which are designed to engage students more actively that involve new technology and multimedia, but in an ancillary and complimentary way and not as the *raison d'être*. Student engagement and collaborative learning are the main features of these programs. A number of these funded by NSF are underway at this time. "Sweeping Change in Manageable Units: A Modular Approach to Chemistry Curriculum Reform" [Modular Chemistry Consortium, MC², <http://www.cchem.berkeley.edu:8080/>], "ChemLinks Coalition: Making Chemical Connections", [spencer@beloit.edu], and "Establishing New Traditions: Revitalizing the Curriculum" [moore@macc.wisc.edu] represent three efforts currently funded by NSF as an attempt to break out of the traditional lecture mold. Many other similar activities are ongoing.

Certainly, many aspects of teaching chemistry are and will continue to be profoundly influenced by computer technology. But one gets the clear impression that much of our current fascination with technology is faddish and will produce few memorable improvements in chemistry teaching. Perhaps it is the novelty of using computers actively in exercises that engages some students, but this engagement, much more than the computer, is the key to improving student performance.

Using MathCAD in High School and Freshman Chemistry

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The chemistry course at the Governor's School is taken primarily by juniors, and some of the sophomores who enter the school as ninth, rather than tenth graders. The course itself is not high school chemistry, nor is it AP chemistry, rather it is like freshman college chemistry. The textbook currently used is *General Chemistry, Third Edition*, by McQuarrie and Rock.

The calculus course at the Governor's school uses MathCAD for MacIntosh, and there is limited use of it in the precalculus course. Because most of the chemistry students are in precalculus or calculus it is only natural that MathCAD be used by students taking chemistry.

I decided that the best, and simplest way to introduce MathCAD in the chemistry course was to have the students first use it to solve an equation, and then a couple of weeks later progress to graphing Beer's Law and kinetics data. I decided that the Rydberg-Balmer equation would be a great place to start. The students had just finished an activity in which they had observed the line spectra for several elements using spectrum tubes and hand-held spectrometers. They used a spreadsheet to calculate the frequencies and energies of the lines they had seen, and until last year they had also used the spreadsheet to solve the Rydberg-Balmer equation for the initial energy level of the hydrogen electrons. Most of the students were eventually successful, but it took several attempts to get the equation entered correctly, because all the nested parentheses that were needed to get the operations grouped correctly.

It was at this point last year that I participated in a workshop on MathCAD for the science faculty which was presented by our math faculty. I used the Rydberg-Balmer equation to practice my newly learned skills and was very impressed with the software and the appearance of the final product. MathCAD allows you to type out the equation the way it appears on paper. It is easy to enter text to define variables and constants and any other descriptions that might be desired. All of the Greek symbols are also supported, a feature I think is very important.

The class meets in the computer lab the day I introduce the students to MathCAD so that each student can work

on a separate computer at their own speed. I use an overhead display panel to show them how to enter text and how to manage the math mode. Some of the commands are really not very intuitive, as they are unique to MathCAD. Here is an example of how one student carried out the assignment this year.

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Purpose: To use the Rydberg-Balmer equation to calculate the initial energy level for the hydrogen spectra as determined in Experiment 13.

λ = wavelength
 x = Balmer Constant
 n = initial energy
 i = counter

$$i := 1..3$$

$$x := 1.097 \cdot 10^7$$

$$\lambda_i :=$$

$435 \cdot 10^{-9}$
$490 \cdot 10^{-9}$
$660 \cdot 10^{-9}$

$$n_i := \frac{1}{\sqrt{\frac{1}{4} - \frac{1}{\lambda_i \cdot x}}}$$

n_i

4.973
3.954
2.99

The graphing assignment is coming soon, but I have changed it from what was done last year. That assignment was for the students to set up templates to graph Conc. vs time, ln Conc. vs time, and 1/Conc vs time for five sets of kinetics data. Then for the equation that showed a straight line they were to determine the order, the rate, and the rate constant for each set. This year they will have only one of this type of problem. They will also be asked to graph $V/T = k$ and $PV = k$, where k is a constant, using a minimum of 5 points for each. In addition, they will be given in $P = A \cdot \Delta H_{\text{vap}}/RT$ and values for vapor pressure and temp and determine the

value of ΔH_{vap} . Lastly, they will be given solution concentrations in molality and boiling points and after graphing conc. vs b.p., determine the slope to obtain K_b . I had my classes do this assignment on Kaleidagraph for several years to help them learn that graphing software, but since almost all of them are quite proficient at it when they come into chemistry, this seems like an excellent way to provide experience in graphing with MathCAD.

The specific directions that are given out to the students pertaining to MathCAD itself and the assignment details can be viewed at the website given above. I want to acknowledge the help of the math faculty at the Governor's School who showed me how to use MathCAD and who developed the student directions for the various assignments. Thanks go to Julie Taibbi, Susan Kennedy, John Cannaday, and Ken Weddle.

ELECTRONIC CLASSROOMS

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You can't see atoms or molecules. Students have to establish a mental picture of atomic and molecular structure to understand chemistry. During the last year and a half we have been experimenting with the use of Pentium and Macintosh electronic classrooms in organic chemistry and biochemistry instruction. We find that the use of visualization software is an excellent tool to help students understand molecular structure.

Bridgewater State College has recently completed the John Joseph Moakley Center for the Application of Technology to Education. The building has two 26 seat Pentium electronic classrooms and one 24 seat Mac electronic classroom. Each classroom has two microcomputers set up for wheelchair access, and the building also houses an adaptive computing room where special software is provided. Each electronic classroom has a faculty station consisting of a cart equipped with a microcomputer with CD-ROM, a video visualizer, a VCR, a laser disc player and a network connection. All of these are connected to a Sony three-gun projection TV system through an audio/video switch, and an Extron converter box. The individual microcomputers also have 4X CD-ROM drives and network