Computer Simulations and Tutorials for General Chemistry at University of Missouri-Rolla

Gary L. Bertrand, Professor of Chemistry

Abstract
About the Course
Introduction
Appraisal of Individual Students - Remediation and Review
Interactive Lecture Aids/Simulated Demonstrations
Simulations in the General Chemistry Laboratory
The Future

Color Coding of Text

Blue/Purple:Links to Web Materials

Red: Web Materials Requiring Plug-In
http://www.umr.edu/~gbert/tutorials.html
Notes on Installing the Windows Plug-in

Green: Materials for Downloading
Notes on Downloading
ftp://www.chem.umr.edu/bertrand
Macintosh: CCSim.sea.hqx, OmoMac.sea.hqx
Windows: CCSim.zip, OmoWin.zip
These may be decompressed with various programs, but I recommend Aladdin Expander at
http://www.aladdinsys.com/expander/

Abstract

Computer Simulations have been used in Chemistry courses at UMR since the early 80's. These began with an interactive simulation of the Iodine Clock reaction, which was used as a demonstration in a lecture room with 30 students grouped around the 13" monitor of an Apple IIe computer. While the students at that time were somewhat distracted by the technology, the educational impact was obvious. My assessment of that impact assigned equal weight to the effects of visualization and interactivity, and these have been the cornerstones of my software development and use.

Simulations and interactive software have been developed for **Appraisal of Individual Students/Review and Remediation, Interactive Lecture Aids/Simulated Demonstrations,** and as **Simulations for the Laboratory.** Materials have been delivered as recorded media, LAN servers, the Internet, and in a Computer Classroom used in conjunction with the Laboratory. Cross-platform issues have been, and still are a major concern. One overriding observation has been that the availability of electronic materials for out-of-class use

tends to broaden the performance gap between the top and the bottom of the class. In-class use tends to narrow that gap. Some of these materials will be made available through an FTP site.

top

About the Course:

The University of Missouri-Rolla has been listed in the top 100 of Yahoo's **"Most Wired Campuses"** since the listing began in 1997. All of our residence halls, fraternity, and sorority houses are wired. There are approximately 20 WinTel machines, 12 Macintosh Power PC's, and 30 Macintosh Power PC/Windows machines available on a walk-in basis in the building, which houses Chemistry, Chemical Engineering, and a small Biological Sciences Department. Similar numbers of machines, but heavily slanted toward WinTel, are available in most buildings on campus.

Our student body is heavily oriented to Engineering (90%) and Science (5%) with average ACT scores of 28, and Chemistry is required in most of these majors. All students are required to take a Chemical Safety Course (Chem 4, 1 credit hour) as a pre- or co-requisite for any Laboratory course on campus. About 20% take this in one concentrated week prior to classes during Freshman Orientation. The remainder take it as a daily class during the first 3 weeks of the semester. Only two General Chemistry sequences are offered, and one of these (Chem 5) is being dropped. Chem 5 is a one-semester accelerated course (5 credit hours, including Lab) for students with a strong High School background that will not take any higher-level Chemistry (about 20% of our students, mostly Electrical Engineering majors). A small percentage of incoming students are prohibited from taking Chemistry until they have completed a remedial mathematics program in Algebra, though a substantial number of these students have completed High School Calculus. The remainder (many of these are taking a one-semester Algebra + Trigonometry sequence) take a four hour (Chem 1, 3 hours lecture + 1 hour recitation) course plus a one-hour (Chem 2) Laboratory in the Fall, then a three-hour (Chem 3) lecture course in the Spring.

My first-semester Chem 1 class normally has 100-120 students, primarily from Basic Engineering (they move into specific engineering areas in their second year) and 6-15 chemistry majors, plus a few majors from Biological Sciences, Physics, and "undeclared". They are subdivided into 6 recitation sections. The entire class meets for three 50-minute sessions per week, then the recitation sections meet with a Teaching Assistant for one 50-minute session weekly. Recitation usually involves a weekly quiz which is taken verbatim from assigned problems or computer tutorials, and remaining time is usually spent working problems with the TA. The laboratory is separate from the lecture course, though there is a strong effort to keep the two "in sync".

For the General Chemistry Laboratory, we use a mixture of modular experiments from Chemical Education Resources, Inc., and locally - produced experiments. The laboratory course normally involves one faculty member with overall responsibility, coordinating 6-9 time slots per week in the Fall semester and 1 or 2 time slots per week in the Spring. Each time slot involves one faculty member, four TA's, and an assigned grader operating four sections of eighteen students each in two rooms separated by a stockroom. The students meet in a large lecture room (equipped with internet access, a dedicated computer, and a permanently-mounted projector) for approximately one hour to turn in the previous laboratory report, take a pre-lab quiz (optional for the instructor), and receive background information (lecture, modifications to procedures, safety considerations, etc.) on the scheduled activity. The faculty member has primary responsibility for this presentation, but this is often delegated to the TA's. The students then move to the laboratories or computer facilities. The lab course has #1 priority for a computer classroom with 18 machines at 2-person stations, and high priority for two additional rooms (not so well-designed for classes), each with 12 machines.

The computer classroom was first used in Fall '98. It represents the cumulation of about five years of begging, arm-twisting, and outright pushiness on my part. It was designed with the help of departmental staff - a research engineer (electronics and computers), an electronics technician, and a general handyman (glassblower, electrician, cabinet maker, and upholsterer). They put it together and covered my mistakes. The room contains 18 Macintosh G3 Power PC's (OS 8.1, 233 MHz, 3 GB HD) with Orange Pci (Pentium II, 200 MHz, 1 GB HD) boards running Windows 95, with complete Internet access and password access to practically every server in the four-campus University of Missouri System. Monitors are embedded in the 2-person desk under a glass plate, so that the room may be used as a conventional classroom (albeit with a few distractions). There is also an instructor's machine connected to a ceiling-mounted projector.

I have been developing computer simulations for both research and teaching since the early 70's (starting on the Wang Programmable Calculator), following a model that I first proposed in 1967. Visual components were added in the early 80's, starting with the Apple IIe Computer. The simulations were developed primarily as lecture aids, because at that time our average student was not sufficiently familiar with computers to be able to separate the two learning curves involved - the use of the computer itself and the material being presented. Those considerations are no longer applicable as the sophistication of both students and machines has increased greatly over the years.

While many of today's students are more proficient in the use of electronic materials than their instructors, there are still some in the General Chemistry class who are not yet comfortable using email and the internet. In order to get them "on-line" as quickly as possible, I have electronic assignments for nominal credit in the first two weeks of class. The first is a **questionnaire** on the Web regarding the students' expectations for the course, taken directly from Eric Mazur's book **Peer Instruction** [Prentice-Hall, Upper Saddle River, N.J., 1997]. I personally contact any students that do not respond, and invite them to a help session in the Computer Classroom. The **second assignment** is for the students to email me with their seating preference in the classroom (if any) and to introduce themselves. The introductions vary from "Hello, I'm ----." to lengthy discussions of their backgrounds and plans. These assignments have provided an unexpected bonus, in that the rapport between me and the class that would normally take a month or more to develop is almost immediately in place. I feel that I know the students better, and they seem to feel that they know me better.

top

Introduction

There's an old saying, "When the only tool you have is a hammer, every problem looks like a nail." For my email signature, I have used the quote, "The practice of Chemical

Thermodynamics is simply a matter of finding the proper wrench to pound on the right screw." Both of these statements backhandedly make the point that we often choose a tool because of its availability, not necessarily for its appropriateness to the job at hand. However, we prefer to hire workmen (carpenters, mechanics, bookkeepers, technicians, programmers, etc.) who know what tools are required for the job we want them to do, know how to use them, and either have those tools or know where to obtain them. Most jobs can be done at varying levels of efficiency and effectiveness, depending on the availability of different tools and their costs. Determination of the "best" tool for a particular job to be done at a particular point in time must be based on the worker's proficiency with available tools as well as on time and budgetary restraints.

As teachers, we are normally faced with a specified amount of material that is to be "covered" with a specific group of students in a fairly rigid framework of time and space. That teacher must get the job done with that group of students in the best way possible with the resources available at that time. The traditional tools include Lecture/ChalkTalk (the all-purpose hammer), Laboratory, Demonstration, and an assortment of Teaching Aids (posters, slides, overheads, videos, films, etc.) which might be considered as enhancements for lectures or even as substitutes for demonstrations. Homework, take-home projects, and studying for quizzes/exams are employed in an attempt to use out-of-class time to enhance learning. More recently, cooperative methods utilizing peer instruction have been added for classroom applications and group projects for out-of-class participation. The even more recent developments in Distance Learning are increasing the need for teachers to acquire new tools at an ever increasing rate.

All of these tools require varying degrees of preparation and varying dependencies on the resources available to the teacher. Even the simplest forms of projectors will occasionally fail, demonstrations will go awry, and supporting materials are delayed or otherwise not available; often scrapping the planned classroom activity and usually leaving the instructor to fall back to a less technological method. The popularity of Lecture/ChalkTalk as a teaching tool probably derives more than anything else from the fact that it allows the instructor the greatest control and the least dependency on outside factors. Teachers who are experienced with cooperative methods may be able to shift to this mode when technology fails, but for optimal effectiveness, these methods require substantial preparation on the part of the students. In truth, any effective teaching method requires preparation by both students and instructor, and the lack of preparation by one or the other usually becomes apparent rather quickly. Lecture/ChalkTalk, however, can proceed smoothly with no preparation on the part of the students (even with a substantial number of them asleep), and in some cases with little or no preparation on the part of the instructor.

Computerized materials provide another set of tools that teachers may use to accomplish their task. At the very basic level, a digital projector and an internet connection allow all of the resources of the Internet to be brought into the classroom. Alternately, students may be required to view such materials as preparation for class or for extended assignments. Contrary to the claims of educational hucksters, the availability of these materials do not make the teacher's job easier. Effective use of these materials requires a great deal of preparation on the part of the teachers - they must locate appropriate software or internet resources, review them for applicability to the class, and develop a scheme of preparing their students to receive these materials for optimum effectiveness. The rapid development of electronic educational materials is both a blessing and a curse to instructors. The amount of time required to maintain currency is steadily increasing. Unfortunately, the time and effort spent on this type of preparation is often not recognized by administrators or even by other teachers. My assessment of this technology is that it doesn't make the job easier and it doesn't allow you to do a better job with the same amount of work - it allows you to do a much better job, but only with the investment of more time and effort.

In teaching any course, there will be several stages of development - appraisal of the background of students relative to course material, getting acquainted, introducing new material, testing, etc. The available tools will have differing degrees of applicability to each of these stages, and the applicability of each tool will depend on the instructor, the students, and the specific material involved. There will also be some variation in the order of these stages for different circumstances.

top

Appraisal of the Readiness of Individual Students for the Material, Remediation, and Review

Generally, there will have been campus-wide testing of the students' basic communications and mathematics skills. A multiple-choice quiz can quickly provide information on the student's present strengths and weaknesses in the course material. However, many of the students took their high school chemistry in either their Sophomore or Junior year, and their present abilities may give a poor evaluation of how they can be expected to perform in the course. A personal interview can add greatly to this evaluation and can have a major impact on establishing student - teacher rapport, but this can be prohibitively time-consuming for larger classes. Using the results of this testing to devise a plan to guide the student's remediation and review is likely to be even more time-consuming, and will likely require resources that are not available.

A system of self-appraisal and asynchronous remediation is potentially the most efficient tool for all involved. Computer-based test/tutorials have been developed for very specific areas related to our first-semester General Chemistry course - **Names of Elements**, **Ions**, **Binary Compounds**, and **Ionic Compounds**(see **ChemicalNames**). Similar programs have been developed for basic arithmetic skills - **Significant Digits**, **Prefixes and Multipliers**, and **Estimated Calculations**, an exercise designed to make students less blindly dependent on calculators. These tutorials are available on the **Web** **http://www.umr.edu/~gbert/tutorials.html**and in Computer Learning Centers (CLC's) on campus. The Course Syllabus states, "The first 2 Quizzes will cover names and formulas of Elements (Rows 1 - 5 of the Periodic Table) and Ions. You must receive 70% or better on these quizzes within the first four weeks to remain in the course." In Fall '99, the four naming programs were accessed over 3000 times over the Web in the first four weeks of class (and 1000 times over the remainder of the semester). All of my students passed the quiz on naming **Elements**the first time (average 85%), 94% passed the quiz on **Binary Compounds** (average 90%), but only 75% passed the first quiz on **Ion Names.** The percentage passing rose to 88% after the second **Ions** quiz, and that number rose to 100% after an evening session that was somewhat "up close and personal".

There is no specific test of mathematical proficiency, though the students are warned that points will be deducted for improper use of significant figures and scientific notation. The students are shown how to access these materials in the first class (a computer, internet access, and a projector are available in the lecture hall), and I am available for 2-3 hours one night a week in the Computer Classroom. No student has ever been dropped for failing to meet the quiz requirements in the four years I've used this system, though some have dropped voluntarily. About 4% of my students require a considerable amount of help to meet the requirements. Very few of these complete the course. The overall "drop + failure" rate for this course is about 15%, though that number dropped to about 5% in Fall '99.

Most of the tutorial programs for General Chemistry can be used in **Assessment**, **Remediation**, and **Review** for higher-level courses. A new tutorial **Mixing Solutions** (plug-in is required) is being developed for assessing problem-solving skills, and to help students bridge the chasm between the way that mathematics is taught and the way that it is applied in Chemistry. An animated representation of the process, and a requirement for interaction (trivial as it may be) are expected to aid in the assimilation of problem-solving skills.

top

Interactive Lecture Aids/Simulated Demonstrations

Many of these materials are available on the Web for students to use outside of class, but I do not feel that this is generally an effective use. They were not designed to teach the average student, but as tools for an above- average instructor. Most of the materials require a bit of introduction by the instructor, and coordination with the text or other course material.

The simulation **Iodine Clock Rx (batch)** has been used here for over 15 years as a lecture aid in General Chemistry and in Physical Chemistry II, to introduce the Method of Initial Rates for determining the order(s) of a reaction. It was developed on the Apple IIe, and was used in small classes with the students huddling around a 12" monitor and in large classes with a 60" 3-beam projector. It was also used by other instructors in Physical Chemistry Lab a few times in lieu of the actual experiment. One semester I found myself teaching the kinetics unit in both General Chemistry (early in the semester) and Physical Chemistry (late in the semester). I gave the same lecture/demonstration using this program to both classes with little other discussion of Initial Rates, then gave both classes the same problem on their exams. Both groups scored better than 90% on this problem, which I had previously rated at about 75% for Physical Chemistry exams. **Iodine Clock Rx (flow)** adds another dimension to this presentation, with the time aspect visually appearing as distance. This has also been used in higher-level courses to introduce methods for studying fast reactions. After great frustrations in trying to perform flow experiments in the Physical Chemistry Lab, I cannot fault anyone for using this simulation in lieu of the actual experiment.

The visualization in this simulation is nothing more than a color change, but it demands involvement on the part of the viewer. This seems to transduce the subject from algebra and calculus to common sense - if the reaction goes twice as fast, it will take half as long for the color to appear. If we double the concentration of iodate ion and it goes twice as fast, it must be first-order because the rate would have quadrupled if it was second-order, and then it would only have taken one-fourth of the original time. The algebra and calculus, and perhaps the chemistry, all make more sense AFTER this frame of reference has been established. I have on some occasions supplemented this simulation by showing the actual reaction and the real color change, but the students have always shown more interest in the simulation than in the reaction. In any case, the simulation allows the demonstration of many more reaction conditions, including temperature effects, than could actually be attempted in a classroom situation. Even if the instructor fouls up in "preparing" the solutions for the simulation, the mistakes are completely traceable and correctable with little loss of time and minimal confusion of the students.

My favorite part of using this simulation comes after we have gone through enough sets of conditions to determine each of the orders, varying one concentration at a time. Then I prepare a new set of conditions, varying the concentrations of two components simultaneously, and ask the class to predict the outcome. I list the predicted times sequentially on the board, and ask the class to vote on their choices. General Chemistry classes generate considerably more noise than Physical Chemistry classes, and the younger students are more scattered in their responses. The older students are just as interested, but tend to wait for the "top students" to respond. When the simulated reaction "runs" under the new conditions, there are scattered "boo's" as predicted times are passed and a big cheer as the color changes. After two or three episodes of this type, the entire class is predicting the correct outcome each time.

A simulation **pH Titration** (also dating back to the Apple IIe) has been used as a lecture aid to illustrate many aspects of acid/base behavior. The comparison of titrations of acids and bases of varying strengths is an obvious use, but a knowledgeable instructor can also use these curves to illustrate buffering, concentration effects, polybasic acids, and titrations of mixtures. This familiarization with the program enables students to use it on their own in higher-level courses such as Analytical and Physical Chemistry.

The animation **Bomb Calorimeter Assembly** can be used as a lecture aid to add more meaning to a discussion of **Heats of Combustion**, especially if the actual apparatus is not available. This animation was built from the graphics used in a simulation of the experiment, complete with unknowns, which is used in Physical Chemistry Lab. Other animations, **Buoyancy** and **Dissolution Processes**, can be used as starting points for class discussions.

The simulation **Gas Laws** (there are slight differences between the simulation on the Web and the accompanying program **GasLaws**) was developed in an attempt to make calculations on ideal gases more meaningful to students, by providing visual depictions of the processes and a small amount of interaction. The program starts with a cylinder being loaded with a gas at 1.00 atm pressure and an arbitrary temperature (0 to 500°C) and volume (0.2 to 2.4 L). The web user may then choose a condition to perform a process (constant temperature, pressure, or volume), then operate controls to change one property and watch the other unrestrained property respond. A question or problem may be requested, yielding a question based on the current condition of the apparatus asking about the response to a specific change in one of the properties. The controls are frozen until an answer is provided, then the user is allowed to operate the controls to impose the new condition and observe the response.

top

Tutorials for Self-Study

Ten of the tutorial exercises were specifically assigned to Chem 1 in Fall '99, such that students were responsible for this material on recitation quizzes. These ten exercises were accessed via the Internet a total of 2961 times during the semester with about 20% of the accesses coming near the end of the semester, apparently as a review for the final exam. These exercises are also available on the 42 Macintosh computers in CLC's in the building, and these were heavily used in the week before the final exam. My experience has been that even the top students do not use these tutorials unless they see a direct or indirect payoff, such as a high correlation between the quizzes and the tutorials. Poorer students do not use them unless there is a direct payoff, as in credit for an assignment. This has led to what is known on campus as **Bertrand's Adage** , "No credit - forget it!", and to a broadening of the gap between the top and bottom students in the class.

top

Simulations in the General Chemistry Laboratory

Simulations have been used extensively here for pre-lab lectures for about five years. We use a complete simulation of the experiment **Colorimetry and Spectrophotometry** that our students perform in the laboratory. The **Colorimetry** (see **clrSpec**) part of the experiment is available on the Web. Students prepare a set of calibrated standards by mixing dyes and water dropwise, and estimate the concentrations in two unknowns, a diluted dye and a mixture of two dyes. In the **Spectrophotometry** part of the experiment, a Spectronic 20 Spectrophotometer is used to analyze the same unknowns. The program has built-in instructions for operating both the real and simulated instruments. For demonstration purposes, the simulation has a couple of features that are not available on the actual instrument, **autozero** and **autoscan**. The latter produces the spectrum of the sample from 400-700 nm, and allows comparisons of several spectra. The simulation allows the instructor to run through the entire experiment projected onto a large screen in about 10-15 minutes. The experiment then runs very smoothly in the laboratory, even though it is complicated by half of the students starting on **Colorimetry** and half starting on **Spectrophotometry**, to relieve stress on the instruments.

We have used the modular experiment, "Statistical Analysis of Experimental Density Data" [PROP 353, Chemical Education Resources, Inc.], for several years. Several samples of 5 - 8 glass beads (boiling stones) taken randomly from a large supply are either weighed or their volume is measured by displacing water in a buret. Means and standard deviations are determined, and the density and its uncertainty are calculated from the mean mass and mean volume. In Fall 96, we began using the simulation **Glass Beads** (**beads)** in conjunction with this experiment, using the two small computer rooms that were then available. The simulation allows the user to choose the number of beads to be delivered either to a balance for weighing, or to a volumetric device (something of a cross between a buret and a graduated cylinder) containing a liquid. The simulation may be operated so that the beads for the two measurements are completely randomized, or they may be "coupled" so that the same samples are used in the mass and volume determinations. The instruction sheets that are placed at each computer station are included in the **GlassBeads** folder, along with copies of the data sheets and the Excel spreadsheet.

The simulation is used by the instructor as a lecture aid in discussing the experiment. Half of the students then begin the experiment in the laboratory and half on computers. Data is taken in both phases of the experiment, but the simulated data (which contains randomized variations) is transferred to a spreadsheet template for statistical analysis. I consider this an optimal use of a simulation. In the actual experiment, the students learn (admittedly just a little) experimental technique of using a top-loading balance and reading a buret, and they are exposed to some sources of error that are not easily simulated (miscounting beads, contaminating the beads with extraneous materials, leaking burets, etc.). There is a rapid dropoff in the benefits realized per unit time in the actual experiment. The computer simulation, however, generates large quantities of realistically scattered data in a very short time. The simulation is also available for students to re-do on their own. A surprising number of students do this in the evening after their lab, and the most common explanation is "my partner hogged the computer".

While not required in the lab, the simulation can be used to probe more deeply into statistics, such as how the variance of the set and the variance of the mean are affected by varying the number of repetitions and/or the number of beads in the set. The students are encouraged to compare the observed deviations from the mean to the statistical predictions. A discussion of **Uncertainties** is available on the Web, provided for Physical Chemistry students, and as much for the General Chemistry Teaching Assistants (who are very inexperienced in processing experimental data) as for the students.

We have recently added the simulation **Nuclear Decay t**o the General Chemistry Laboratory. For many years, we have used a Radioactivity "experiment" in this laboratory. The students receive a lecture/discussion on nuclear notation, particles, and reactions, and on first-order decay. They then go in groups of 20 to our campus reactor to see a sample of aluminum irradiated and the gamma radiation counted for several half-lives. In the past, their lab report was basically two graphs, counting rate vs time and the corresponding logarithmic plot. Beginning in Fall '98, they receive the same lecture, then go either to the reactor or to a computer classroom. In the computer classroom, they perform the simulation, logging in with a code that gives each pair of students a unique "reaction" to study. They obtain data at two or more levels of radiation. They estimate the half-life from direct observation of the time required for the counting rate to be halved three or more times, then they enter the data into a spreadsheet, create graphs, and obtain the rate constant (and the half-life) by regression analysis. This group then goes to the reactor and the other group works with the simulation.

Computers were introduced into the General Chemistry Laboratories (one computer shared by a group of four students) in Fall '98, using the Vernier Lab Interface on old computers retired from our Computer Learning Centers. These are presently used in experiments on **Colligative Properties** and **Gas Chromatography**. A new experiment on **pH Titrations** will be added in Fall '00, utilizing the simulation **pH Titrations** in the Computer Classroom, and in the pre-lab lecture.

The General Chemistry Laboratories were renovated in Summer '99. Early in the process, we became aware that they would not be ready for use until the third week of the Fall semester. We decided to use a simulation, **Buoyancy Programs** [J. Chem. Educ: Software, Vol. 7C (1), July 1995], to be followed by the Glass Beads simulation discussed previously. The buoyancy simulation was modified to include individualized unknowns, and a formal "experiment" was prepared. An animated **mini-lesson** was also prepared for a pre-lab introduction via the internet. In this "experiment" the specific gravity of two known solids and an unknown solid are determined by two simulated techniques, then the densities of two known liquids and an unknown liquid are determined.

Another simulation **Gases**was designed as a pre-lab for an experiment that was originally developed for the General Chemistry Lab. We have not been able to overcome the logistical problems in using **this experiment** in the large labs, but I have used it on a smaller scale in the Physical Chemistry Laboratory. The students are assigned an unknown gas, and its molecular weight must be reported correctly for a student to be allowed to actually perform the experiment. The **Bomb Calorimetry Simulation** mentioned earlier is also used in this way as a pre-lab experiment with an unknown for the Physical Chemistry Laboratory**.** Another simulation of **Freezing Points of Binary Mixtures** is used in Physical Chemistry in lieu of an experiment. Using the simulation, students determine the freezing point depression constants of two solvents, and determine the molecular weight of their "unknown" in both solvents. The simulation allows acquisition of data over a range of compositions, such that extrapolation techniques are required to obtain the "best" values for the unknown. The students perform another experiment in which cooling curves are actually observed, **Solid - Liquid Equilibrium in a Binary System**, so that the experimental aspects of freezing point depression are not overlooked.

top

The Future

I have encountered a number of impediments in using Simulations as part of the teaching process, but these are rapidly disappearing. In the early days, students were overpowered by the compounded complexities of interacting with the computer, the crude visual presentation, and the general problems of assimilating the concepts that were presented. Today's computer-wise students arrive with sufficient skills to minimize the amount of time that must be spent on the mechanics of the operation. This has been made possible by the advances in speed and sophistication of the machines and their operating systems, as well as the general experience of the students in using computers throughout their education. I estimated that only about 2% of my students this year were uncomfortable with the use of computers as part of class or assignments, by the time they had finished the first semester.

I believe that the major advancement has been in Accessibility - access to the machines is obviously important, but access to materials is even more important. The Internet has opened many of these doors, not only to software that can run directly through a browser, but also in access to FTP sites and in simplifying the procedure of downloading programs and other materials. In the past two years I have shifted the delivery of more than 90% of my materials from campus servers to the Internet. Recent developments in simplifying and lowering the costs of preparing CD-ROM materials are increasing accessibility. Cross-platform issues will probably continue to impede the development and dissemination of interactive materials to some extent. The materials made available through FTP were developed with **Oracle Media Objects (OMO)**, which is no longer supported by Oracle. The Web materials were developed with **SuperCard** and are delivered via the **SuperCardWeb Plug-in**, but the internet mode of this authoring environment is not nearly as robust as the parent program. I have started working with **Macromedia's Director** and **Shockwave/Flash Plug-in** for Web delivery, but I find the movie metaphor of this system very restrictive for the type of interactive software that I develop.

In the very near future, students in ordinary classrooms will have greater access to electronic materials than my students presently have in our Computer Classroom. Every student will have some type of monitor at their desk with access to the Internet and various Intranets or Servers, most likely through wireless connections. Guided access to Simulations and Simulated Experiments will bring the flavor of the laboratory into the classroom (without the smells).

The major disappointment that I have encountered in developing and using electronic materials in my teaching is that only one of my fellow faculty members has used these materials in his classes. There has been general recognition by other faculty of the effectiveness of these materials, and there has been a slow but steady increase in usage by Teaching Assistants in Recitations and Laboratories. There is perhaps an element of "trying to teach old dogs new tricks" here, since of the seven faculty who have been involved with General Chemistry Lecture Courses over the past two years only two are under the age of sixty, and those two are heavily involved in Research and/or Administration. There can be no doubt, however, that there is a large activation barrier even for young faculty to develop the expertise for using these materials in a classroom situation, and this barrier grows with every year in the classroom. The REAL evolution of the use of these materials will be hastened by the recognition of these barriers by administrators, and provision of time, materials, and credit for faculty to develop the expertise to overcome them.

top

Notes on Downloading:
1. Macintosh - Before starting the process, check your browser's setting for the downloading destination. (Windows will usually allow you to select this in the downloading process) It is best to create a specific folder and direct the download to it, so that the materials will be kept together.
2. Depending on the extraction software on your machine, the file may still have the **.hqx** suffix, only the **.sea** or **.zip** suffix, or it may have been extracted to the operating components.
3. Expand or Extract the files if necessary. It is important that the un-zipping file be set to "maintain folders (subdirectories)" or "recurse folders".
4. Check the expanded files against the listing below - there is sometimes a problem with the **OmoWin** folder in Windows, in that the three subfolders do not appear, and the individual files are scattered. If this happens, folders with these specific names must be created and the proper files must be placed in them.
5. To run a Program, double-click on its icon. Under **Windows**, you will probably be asked to locate the application through a dialog window named **Open With**. Clock on **Other** at the bottom of the window. Locate **Omoplay.exe** in the **OmoWin** folder, and the program should run.

Compressed Files: (to be downloaded)

Macintosh:
CCSim.sea.hqx
OmoMac.sea.hqx

Windows:
CCSim.zip
OmoWin.zip

Expanded Files: (suffixes may not appear)

CCSim:

Folder - Colorimetry
clrSpc.STA (Program)
colorimetry.msw
colorimetry.wpd
Folder - GlassBeads
beads.STA (Program)
GBds_DS.MSW
GBds_dir.MSW

spreadsheet.XLS
ChemicalNames.STA (Program)
GasLaws.STA (Program)
gases.STA (Program)

Player (Macintosh) or OmoWin (Windows):

Folder - Library
System (Program)
Folder - License or **Distribution License and Agreement**
These items are not used
Folder - Objects
Windows - 7 files with suffix .mox
Macintosh - 15 files like Bitmap(Player)
Omoplay.exe (Windows)
or
OMOPlayer (Macintosh)

top

Setting up the Windows SuperCard Plugin with Netscape (best with Netscape 4.5)
This applies whether you have Netscape only , or both Explorer and Netscape.

Download the Plugin from the SuperCard site, and decompress it.

Find the Netscape Folder on your Hard Drive (C: drive)
Determine whether you have Communicator + Navigator, or just Navigator

Find the Application "SCPlugin_setup" (it's where you directed the download)
Double-click on the icon for "SCPlugin_setup"

A message box will appear "Pre-setup will prepare ..." Click on "OK"
You will see the time bar filling in.
Click on "next" until you see the window: DIRECTORY
Click on "Browse"
Locate the Plugin folder for Netscape Communicator (or for Navigator IF you don't have Communicator):
It is usually on the path:
Win95(C:)/Program Files/Netscape/Communicator/Program/Plugins
Click on "next". (as many times as is necessary)

Let's hope that it tells you that the installation was successful.

Quit that application.
Start Netscape. Go to **http://www.umr.edu/~gbert/tutorials.html**

Click on one of the tutorials with the Windows flag.

Let's hope that it runs

top
