

Princeton, NJ. Their three studies of web search engines are especially valuable because they are mainly concerned with scientific searches. All are available on the web, including the most recent (<http://wwwmetrics.com/>). Since this is apparently an ongoing study, it would be a good idea to check back from time to time to learn if more recent results have become available.

Danny Sullivan's Search Engine Watch (<http://searchenginewatch.com/>) seems to be the most extensive source of general information about engines. This site includes a current listing of index sizes (<http://www.searchenginewatch.com/reports/sizes.html>). Page down to see that even the largest index is less than half of the total web sites. Sullivan's site also links to many reviews (<http://www.searchenginewatch.com/reports/reviewchart.html>). The only problem with this site is that there is so much information that it is easy to find that you have just clicked away from something that you can no longer find. Either drop bread crumbs as you surf or else use the excellent site-specific search engine that is provided. Sullivan also offers a subscription service that promises even more information, but the part of the site that is open to the general public is an excellent starting point for anyone who is trying to keep up with recent search engine developments.

These sections only scratch the surface of what Sullivan offers. Be sure to look at the informative tutorial on how engines work (<http://searchenginewatch.com/webmasters/work.html>), and Search Tips (<http://searchenginewatch.com/facts/index.html>), which, as the name suggests, explains how the major engines work and how to maximize the possibility that a given engine will give the best possible results. The tutorials are aimed at all levels of experience, ranging from novice (<http://searchenginewatch.com/facts/math.html>), through advanced tips (<http://searchenginewatch.com/facts/powersearch.html>) and boolean algebra (<http://searchenginewatch.com/facts/boolean.html>).

The third major resource on index size and number of dead links is Search Engine Showdown (<http://www.searchengineshowdown.com/>), a site maintained by Greg Notess. He factors the dead links data into the index size charts and gets results that look somewhat different than the numbers that are often cited by the search engines (<http://www.searchengineshowdown.com/stats/sizeest.shtml>). Another feature of Greg's site is Search Engine Inconsistencies. (<http://www.searchengineshowdown.com/inconsistent.shtml>). These pages list search engine problems, both temporary and long-term, for four of the most popular engines, AltaVista, Google, HotBot, and Northern Light.

SECONDARY SOURCES FOR SEARCH ENGINE EVALUATION

After the big three, there are a number of sites that may not be as generally useful, but do have some interesting features. Search IQ (<http://www.searchiq.com/>) has a listing of more engines than you probably dreamed existed, complete with a rating number (the IQ) and some very frank criticisms.

The portal concept is still a hot topic on the net, and if you wish to compare the features of the various portals (which often appear to be search engines to those of us who think the net is primarily an information source instead of a place to catch suckers) there is a site devoted to these comparisons, called traffick (<http://www.traffick.com/>). Even for those who don't care about portals, the set of articles under the general title, "Andrew's Metaguide" offer good analysis of topics related to searching.

About.com uses live guides, who write brief reviews, with appropriate links, about topics of general interest. The special section dedicated to web searching (<http://websearch.about.com/internet/websearch>) is written by Chris Sherman, who has gathered an impressive variety of useful articles and links.

CONCLUSIONS

It seems inevitable that the WWW will continue to evolve rapidly and in unpredictable directions. Search techniques for printed materials may remain relatively constant for years and even decades, but the internet world can change within months or even days. The only way to remain current in the new information environment is to use the environment itself to keep track of new developments. It is hoped that these net references will make this job a little easier.

Using Microsoft PowerPoint in General Chemistry
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Alex Johnstone suggested that chemists view their field within a triangular matrix of ideas.(1,2,3) We make observations of macroscopic physical and chemical changes and codify these observations in symbols, in the form of chemical or mathematical equations. In this regard we are rather like musicians who hear music and represent it on paper in the form of notes

with an indication of time and key. But chemists go beyond this by trying to visualize what we see and symbolize with models of chemical behavior on the particulate or atomic and molecular level. These visualizations can take the form of physical or computer-drawn molecular models or computer-generated animations. The computer has especially opened up the atomic and molecular level to visualization by chemists and their students, and it is now relatively easy to bring these visualizations to students in our lectures. My interest in using computers in chemical education began about 10 years ago. It was clear that, appropriately applied, computers had the potential of opening up new insights for students and helping them become more involved in the learning process. Our activity in computer-enhanced chemistry has been in four areas: (i) software development; (ii) the use of images, videos, and animations in traditional lectures; (iii) the use of interactive software in tutorials; and (iv) the use of computer-based molecular modeling at all levels of the curriculum. This paper briefly describes only the second of these.

COMPUTER-ENHANCED LECTURES

Our intention is to enrich lectures with visual illustrations of chemical phenomena and representative molecular structures. It is intended to remind the students continually of the triangular matrix of ideas by showing chemical and physical changes, by showing how those are symbolized by chemists, and by modeling these phenomena at the atomic and molecular level. For these reasons, the computer-generated slides used in lectures include photos or diagrams, videos and animations, and molecular models. In addition, a button on a slide can trigger an event such as another program, say an Internet browser, a Java applet, or a molecular modeling program.

Photos and Diagrams

Static visual materials come from a wide variety of sources. One of the best sources are the CD-ROMs publishers provide with textbooks, as these disks usually contain book figures and other images from the relevant textbooks. For example, Saunders College Publishing provides several hundred figures on the Instructor's Resource CD-ROM. The current version of this disk has digital versions of the overhead transparencies from five of Saunders's current textbooks. A utility on the disk allows one to view the figures, modify them, add legends, copy them to a hard drive, or make a slide show from a series of figures. The World Wide Web is of course a rich source of figures. My colleague Harry Pence has recently discussed the sources of images and their uses.⁽⁵⁾ A website that has images that can be used to add "spice" to a lecture is the "Comic

Book Periodic Table."⁽⁶⁾ Digital cameras are now less expensive and widely available.⁽⁷⁾ Adequate images of chemicals, apparatus, or chemical phenomena can be obtained readily and imported into Microsoft PowerPoint™ presentations. Finally, relatively inexpensive color scanners can be used to obtain digital images from books and magazines (although personal experience suggests that it takes practice to obtain high quality images).

Videos and animations

Videos of chemical phenomena and animations of processes on the atomic and molecular level are especially useful. In our case, virtually all are from the Saunders Interactive General Chemistry CD-ROM.⁴ Other sources include the disks distributed by JCE: Software. Materials we have found especially useful are: a) The Periodic Table CD, Special Issue 10, October 1995 b) Solid State Resources, Special Issue 12, December 1995 c) Periodic Table Live!, Special Issue 17, July 1997 d) Chemistry Comes Alive!, Volume 1, Special Issue 18, 1998 It is also possible to make simple animations using drawing programs. A sequence of drawings can be generated and then assembled into a movie using Quicktime Pro™ or other similar software.⁽⁸⁾ Finally, one can make videos of chemical phenomena, and the videos can be turned into digital movies adequate for chemistry lectures. This of course requires one of the new digital movie cameras or a digitizing board in a computer to convert analog movies.

Copyright Issues

Before going on, it is well to mention that most of the images, videos, and animations one is likely to use are under copyright by an individual or publishing company. Although the laws surrounding the use of copyrighted digital images in the classroom are not yet completely clear, and are very much under review, it seems that use of copyrighted material in lectures would fall under the "fair use" part of the law.⁽⁹⁾ That is, it is acceptable to use such images in the classroom but it is not appropriate to distribute them beyond the boundaries of the classroom.

Molecular Models⁽¹⁰⁾

Chemistry is a visual science, so we use molecular models almost from the first lecture. The Saunders Interactive General Chemistry CD-ROM has hundreds of molecules generated using the software from Oxford Molecular (often called the "CACHe" software, after the original name of the company).⁽¹¹⁾ These models can be viewed using the CACHe software on the CD-ROM and can be manipulated in various ways. An image can be copied from the modeling program and pasted into

PowerPoint. Another method of viewing molecules is with Rasmol, a modeling viewer that can be downloaded from the internet.¹² A large number of models in the appropriate "Brookhaven" or pdb format can be found on the Internet. However, we usually create our own using the CAChe software. The basic version of this software includes a program for conversion of CAChe structures to various formats, in particular to pdb files that can be used by Rasmol. Yet another excellent program for viewing molecular models is MacMolecule or PCMolecule.¹³ The program is similar to Rasmol but displays higher quality images and has much greater flexibility. One can not only rotate molecules on the screen, display ball & stick or other types of representations, and measure bond angles and distances, but the motions of the molecular model can also be recorded as a Quicktime movie. These movies can be played back through PowerPoint or displayed independently.

Putting It All Together in a Lecture

Microsoft PowerPoint™ is a good choice for presenting images, videos, and other multimedia in a lecture setting. It is widely used, can be used after relatively little training, can be used for adequate presentations at the simplest level, and can be used in a very sophisticated manner. Finally, the presentations can be converted for running on the World Wide Web. Building a PowerPoint presentation is relatively simple. One places some text on a slide and adds a photo, diagram, video, or animation. An example of building a slide is given in the accompanying paper, and all of the slides for a general chemistry course are available at <http://www.oneonta.edu/~kotzjc/JCKHome.html>. After having done this for some years, we can offer some guidelines: a) Use text that is large enough to be read in the back row of a large lecture theater. In general, use nothing smaller than 28-point type; 32-point type may be the best size. b) Sans serif fonts (such as Arial or Helvetica) seem more readable than serif fonts (such as Times or Palatino). c) Experiment with different colors and types of backgrounds. Appearance, readability of text, and so on can depend on the brightness of the projector and level of room light. In general, it seems best to use white or single color backgrounds such as blue with black or white text (depending on the background color and intensity). d) Slides should of course be kept as simple as possible with one or two major points being made on a single slide. An important point to be made regarding videos and animations is that their file size can be very large. Therefore, the individual file is not copied from a CD-ROM to the hard drive of the computer used in lecture. Instead, the "insert a movie" command in PowerPoint is used to add the video or animation to the slide, the file remaining on the CD-ROM. When the slide is opened, the opening

frame of the video or animation is shown. To play the movie, PowerPoint accesses the file on the CD-ROM. Thus, while the file size for the lectures on a book chapter may be 5-15 MB, if the movies were added to collection of files necessary to show the presentation, the accumulated file size could exceed 50 MB. We transfer the PowerPoint files to the lecture room computer on a Zip disk or over the campus network. The CD-ROM is mounted in the CD-ROM drive before class begins. The latest version of PowerPoint makes it easy to "build" a slide. That is, once the slide is on screen, some text can be brought in and then a diagram can be built up a piece at a time. Animations can begin when the slide is opened or can be brought in with a mouse click and then played. The PowerPoint slides used in our general chemistry lectures for a portion of the first term of the course are available at <http://www.oneonta.edu/~kotzjc/GenChem.html>. (Note that these slides are in the form of an Adobe Acrobat document and are without animations.)

Using PowerPoint in the Lecture

Although we believe the usefulness of presentation programs such as Microsoft PowerPoint™ is now evident, some may have the opinion it is a passive environment. Rather, we believe it is an enriched environment. I have found that, before showing a video or animation or a slide of information, it is best to develop the ideas first on the blackboard. The PowerPoint slides are used to summarize the idea, to show it more accurately, to expand on it, or to help make the connection between the macroscopic, particulate, and symbolic viewpoints. Availability of PowerPoint Notes The PowerPoint notes are available to our students on several computers in the Chemistry Computer Center. At their leisure they can examine the notes as they would have seen them in lecture and make additional notes.¹⁴ To make this experience even more useful I have added voice annotations that give context to a slide or series of slides. (This is easy to do, but be aware that it adds enormously to the file size. A 10-20 second voice-over adds 300-500 KB to the file size.) In addition to the "live" notes, they are available on our course web site in the form of Adobe Acrobat files (with six slides per page). Thus, students can access them from residence halls or home and can print out a set of notes for a unit of the course. An end-of-semester survey of the general chemistry class indicates that these notes are heavily used.

OTHER ASPECTS OF LECTURES

Using multimedia in lectures is only one of the techniques available to enrich the lecture experience and to engage students more actively.

Demonstrations

Every attempt is made to have a "live" demonstration of a reaction or concept in every lecture. Even demonstrations shown in Quicktime™ movies (or on laserdisc or videotape) are also done "live" as often as possible so the students have a sense of time and scale.

Worksheets

It is important to promote, as much as possible, an active environment during lectures. For this reason students are given sheets with one or two short questions or problems in almost every lecture. We pause during the lecture several times for them to work with their neighbors to answer these questions. I walk around the room during these periods to help them and to assess their progress. Students hand these in and are given credit as part of a block of points that may be earned for lecture and recitation participation and for other activities.(15)

Lecture Outlines

A question often asked about the lectures is if students still take notes when the lectures are laden with graphics. We give students sufficient time during the lecture to make notes, and a cursory examination of their notes indicates that they do indeed sketch important graphics. In addition, we are developing exercises that help students learn to make meaningful sketches of molecular structures. One way to assist students in note-taking has been developed at the University of Auckland in New Zealand.(16) There students in the general chemistry courses are given "lecture shells," a set of incomplete course notes with spaces for them to add information from the lecture. In my lectures while on sabbatical leave at Auckland I gave students shells that contained the key PowerPoint slides but usually with an important point missing. Next to each slide was a space to add additional information. In addition, questions were often added that would prompt class discussion or that could be the basis of an examination question. For example, the lecture shell question associated with a figure on heat transfer asked students to explain how heat energy and molecular motion are related.

Examinations

If we are to present chemistry in an enriched environment, students need to be examined in the same environment. Therefore, the examinations in my general chemistry course now include questions that can only be answered by watching an animation or video demonstration. For example, after watching a short video of an experiment involving the diffusion of bromine vapor in air and in a vacuum, students are asked

to describe their observations and explain why the diffusion rates are so different in the two experiments.

Lecture Room Design

Finally, it is very important that rooms for computer-enhanced lectures be properly designed. The classroom in which my lectures are held has two computers (one G3 Macintosh and one Windows computer), a laptop connection, a laserdisc player attached to each computer, a videotape player, a very good stereo sound system, and two LCD projectors, one for the computers and a second one for the disc and tape players.(17) In addition, there is generous blackboard space and an overhead projector. Of particular importance is the room lighting. It must be designed so that the projector screens are not lighted by room light. At the same time the seating area has to be well lighted so that students can take notes. These conditions are difficult to achieve and may be the most costly item in renovating lecture space.

Student Response

Surveys at the end of the academic year always suggest that students find the use of multimedia in the lectures, combined with other lecture enhancements, to be useful. Results from one recent survey are typical: 55% of the students strongly agreed that the format of the computer-enhanced course was conducive to learning chemistry; 34% agreed and 11% were neutral. None disagreed. When individual comments are solicited, we always hear such things as the following: (a) "Using the CD and computers for more student-centered learning versus lectures would improve learning in chemistry." (b) "The most effective use of multimedia is through integrating the movies and [animations] with the lecture material." (c) Multimedia "can show things that can't be explained as well in a textbook." (d) "The 3D graphics on the CD helped in spatially picturing chemical structures in my mind." (e) The "multimedia devices were incredibly helpful They made the lecture and text materials easier to understand by making some of the abstract theories more concrete. Especially helpful [to understand] orbitals... ." One student comment was particularly striking: "The use of multimedia clarifies ideas that seem to be very abstract. My retention of material is at a much higher level than in other classes." The latter part of this statement is extremely gratifying—if true. In fact, this is a testable idea, and it would be very useful to discover if retention of chemical concepts is indeed increased and if performance in succeeding courses is genuinely affected.

SUMMARY

"Our technologies for representing reality have always constrained the questions we could pose and the things

we could teach." This statement appeared in Campus Tech magazine in 1993 and I believe illustrates the potential impact of computers on chemical education. Blackboards and textbooks did indeed constrain the questions we could ask. Now, however, we can hope to give students deeper insights into chemistry, certainly at the atomic and molecular level. As enthused as I am by our experiment with multimedia, after some years of teaching general chemistry I am convinced that students are better served by an environment in which they spend most of their time engaged directly with the material and only a small amount of their time listening to a lecturer. In this regard, you are urged to read the essay "The New Technologies and the Future of Residential Undergraduate Education" by Gregory C. Farrington.⁽¹⁸⁾ "Some subjects invite far more radical experiments in learning using the new media. Beginning science and math are good examples. It takes an optimistic professor indeed to believe that first-year students learn much physics by sitting through a set of introductory physics lectures. In fact, most students actually learn beginning physics ... when they sit down and grapple with the course content, either in the form of a text or notes, and the problems that accompany it. The lecture may actually be a waste of everyone's time, but it is a ritual that is followed out of habit (on the part of the faculty) or out of fear of missing something that might be on the exam (on the part of students)." (Italics added for emphasis.)

ACKNOWLEDGEMENTS

First, I would like to express my appreciation to my many students over the years who have sat through my lectures and tolerated my experiments on them. I also thank the people in Academic and Instructional Technology Support at SUNY-Oneonta for trying their very best to provide the equipment and services needed. Bill Vining, now at the University of Massachusetts, was my coauthor on the Saunders Interactive General Chemistry CD-ROM; without that software, developed with the help of Bill's creativity and supported by Saunders College Publishing and Archipelago Inc., the lectures would not be as rich. Finally, I thank Dr. Sheila Woodgate for inviting me to spend some time as a Medium-Term visitor at the University of Auckland in 1999. The "lecture shell" idea came from her, and she helped and advised as I experimented on her students in one of their general chemistry courses.

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7. Extensive information on digital cameras is available on the Internet. See, for example: <http://www.dcresource.com>. See also *Consumer Reports*, November 1999, pp. 36-41.
8. An example of relatively simple software for making Quicktime movies is "MooVer," a shareware program from esp Software of Encinitas, California (espsw@compuserve.com).
9. Two useful web sites on copyright issues are: (a) Penn State University Media and Technology Support Services: <http://www.libraries.psu.edu/mtss/fairuse/default.html> (b) The Legal Information Institute at Cornell University: <http://www.law.cornell.edu/topics/copyright.html>
10. Several recent articles on using molecular models are: (a) B. W. Pfennig and R. L. Frock, *J. Chem. Educ.* 1999, 76, 1018-1022 (b) T. Poon, S. A. Bodolosky, and C. M. Norris, *J. Chem. Educ.* 1999, 76, 983-985 (c) H. Ungar, *Syllabus*, May, 1999, pages 53-56
11. Oxford Molecular can be contacted at www.oxmol.com. Our Chemistry Department has a site license for the basic Oxford Molecular modeling software, and it is used at all levels of the curriculum. For example, an experiment has been developed that allows students in general chemistry to learn for themselves the principles of VSEPR theory. A copy of the experiment can be found as a pdf file at <http://www.oneonta.edu/~kotzjc/GenChem.html/111Lab.html>.
12. RasMol is a standalone molecular model viewer and Chime is its counterpart used for viewing model over the World Wide Web. Both can be obtained at <http://www.umass.edu/microbio/rasmol>. This site contains links to support files for the two molecular viewing applications. There are tutorials on using the programs and links to other modeling sites.

13. MacMolecule (and its Windows counterpart PC Molecule) can be obtained from Molecular Ventures, Inc. of Phoenix, Arizona. See <http://www.molvent.com/manual/quick/quick1.html>

14. One problem is that, if students have missed lectures, they are tempted to print out the notes for those lectures, and this can amount of many pages. And, as students do not pay for printing costs, expense to the department.

15. 15% of the course credit may be earned by handing in the lecture sheets, the worksheets used in recitations (where students use the Saunders Interactive General Chemistry CD-ROM), the "Element of the Week" puzzle, and Quick Quizzes.

16. Some of these lecture shells can be viewed at the website for the general chemistry courses at Auckland while they remain. See <http://www.che.auckland.ac.nz/Stage1/Courses/410150/JKotz/JKHome.htm>.

17. If possible, it is very desirable to have two projectors. The video of a reaction or physical change can be run from a tape or laser disk on one projector, and commentary and questions about the process can be on the computer projector.

18. Gregory C. Farrington, "The New Technologies and the Future of Residential Undergraduate Education," *Educom Review*, page 38, July/August, 1999. Using PowerPoint Page 6



Using Multimedia IV -Catching the Students' Eyes

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(Available on the WWW at <http://www.oneonta.edu/~pencehe/mmtutorial#4.html>)

As noted in the previous articles in this series,

there are several sound educational reasons for using presentation software in chemistry lectures. It allows an instructor to combine text and images in a single frame, hopefully making it easier to remember the concepts. Events and processes that were formerly difficult to make interesting now come to life, and students can actually see the real-world applications of chemistry that had previously only been described. Perhaps equally important, although less obvious, is the ability of presentation software to catch and hold the students' eyes, literally guiding their attention through the presentation.

Presentation software packages include various ways to guide the students' eyes. Probably the most important idea to keep in mind, however, is the need to stick to the same process from one frame to the next and to avoid unnecessary distractions. A uniform slide background can provide useful information; but it can also be a constant diversion. Many of the standard backgrounds provided with the software seem to be designed to distract the viewer from the text. During one memorable presentation, every slide was framed with a beach scene, complete with palm trees. Judging from the restlessness of the crowd, the audience kept wondering how this lush background was supposed to be related to the speaker's topic. If the goal was to make them wish that they were somewhere else, it was completely successful. If it had that effect on an interested audience of professionals, what effect would this distraction have on a typical group of students. A typical software presentation package offers a multitude of background choices. Many of these may be artistically interesting but may also distract the audience from the material. Some presenters create problems by using complex pictures as a background. In either case, it may be so hard to find the text that the frames begin to resemble the child's game, "Where's Waldo." A good piece of advice about writing is that if something seems so cute that it is difficult to leave it out, it should definitely be eliminated. Similarly, the best rule with slide backgrounds is simpler is better.

In general, when a frame appears on the screen, most viewers in our society will begin by either looking at the center or the upper-left hand corner of the image. This habit is based on the way that we normally read. It is very helpful to guide the viewer's eye towards that part of the screen which contains the material which is most important in the frame. One way to do this is to make background color a little brighter in the upper-left hand corner (as you face the image) and a little darker in the lower right. The brighter image will naturally draw the eye towards that corner. This is called a gradient and is easy to set with the master frame so that it will always occur in a presentation.