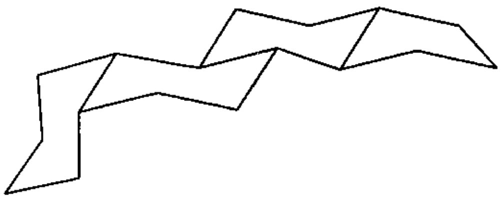
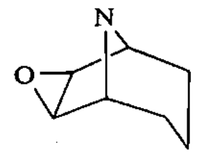
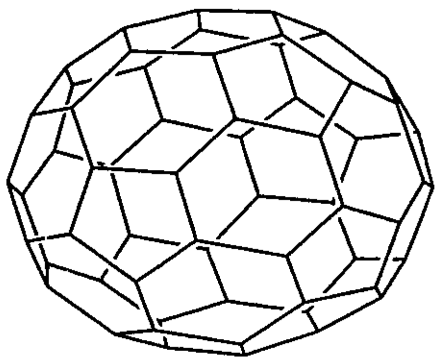
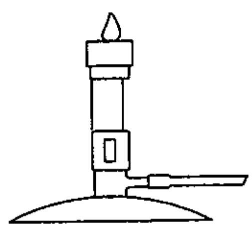
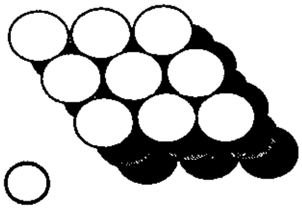
Computers in Chemical Education Newsletter
Fall 1996

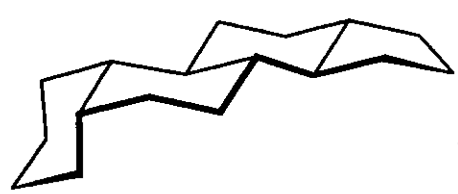












Published by the ACS Division of Chemical Education
Committee On Computers in Chemical Education
Don Rosenthal Chair

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Submissions: General articles should be sent to editor Brian Pankuch at the above address. We would appreciate both 1) printed copy (hardcopy) and 2) a readable file on a Macintosh or IBM compatible 3 1/2" diskette. We have fewer problems with 3 1/2 " diskettes. Email submissions are frequently lost, and formatting and special characters are changed.
Submission deadlines: Fall issue - Sept. 25; Spring issue - March 15.

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RATES: USA 1 year $2.50, two years $4.50: Other countries 1 yr $5, two yr $9. Please make a check or money order payable in US funds to Computers in Chemical Education Newsletter. One to three issues are published per vear.

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Cover: Stuff

The newsletter is set using Aldus PageMaker 5.

COMPUTERS IN CHEMICAL
EDUCATION NEWSLETTER
ISSN 8756-8829

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Contents

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A. SYMPOSIA AT NATIONAL MEETINGS

The 14th Biennial Conference on Chemical Education held at Clemson University on August 4 to 8 contained a considerable number of symposia and papers devoted to the use of computers, multimedia, networks and the Internet in chemical education. This continues a trend noted at the 13th BCCE at Bucknell.

A number of Committee members presented papers or organized symposia at the Clemson BCCE and the Fall ACS National Meeting in Orlando. Charles B. Abrams (McGill University) and Marco Molinaro (University of California at Berkeley) will organize a symposium on "Computer-Aided Immersive Learning Experiences" for the fall 1997 ACS Meeting in Las Vegas, NV.

B. ON-LINE MEETINGS AND SYMPOSIA

An on-line symposium entitled "New Initiatives in Chemical Education" was held June 1 to July 19. The papers and discussion are available on the World Wide Web (http://www.wam.umd.edu/~toh).

An on-line Conference entitled "General Papers in Chemistry and Chemical Education" will be held during the summer of 1997 and the 1997-1998 school year. See the article elsewhere in this Newsletter.

C. ON-LINE INTERCOLLEGIATE COURSES

The CCCE sponsored and helped organize an intercollegiate course entitled "Environmental and Industrial Chemistry". This course was described in the Spring 1996 Newsletter and there are two articles about the course in this issue of the Newsletter. The course papers and discussion are available on the World Wide Web (http://dirac.py.iup.edu/college/chemistry/chemcourse/webpage.html).

I would be interested in hearing from those who are willing to help organize another such course.

D. NATIONAL COMPUTER WORKSHOPS

Three day National Computer Workshops were held last summer before the BCCE at Clemson. Four workshops were offered: The Use of Computers and Computer Software in General Chemistry Jeffrey R. Appling and James D. Spain Using the Internet in Chemistry and Chemistry Courses Thomas C. O'Haver Multimedia in the Classroom Charles B. Abrams et al A Short Practical Introduction to Modern Electronic Structure Methods Wayne Huang.

There were a total of 68 registrants for these workshops. We are exploring the possibility of offering similar Workshops at the 1998 BCCE at the University of Waterloo.

There were over a dozen computer workshops organized during the Clemson BCCE meeting.

E. CCE NEWSLETTER

The publication of this Newsletter represents a major activity of the Committee on Computers in Chemical Education. Articles submitted for publication are printed in a timely manner.

E. OPEN MEETING AT BCCE MEETINGS

In recent years, the CCCE has held open meetings at the Biennial Meetings. These are well attended and provide an opportunity for discussion between Committee members and those attending. A meeting was held at Clemson and another meeting is planned for the 1998 BCCE at the University of Waterloo.

F. WE ALWAYS NEED IDEAS AND SUGGESTIONS

The success of the Committee depends upon our interaction with you and other chemical educators. Please send your ideas and suggestions to me.

Brian Pankuch, Editor
Pankuch@hawk..ucc.edu

Book Review

"Silicon Snake Oil- Second thoughts on the Information Highway," by Clifford Stoll,1995, Doubleday ISBN 0-385-41993-7, 247 pp, $22.

Stoll is a computer expert and astronomer who has been on-line for fifteen years. You can tell he thoroughly enjoys computers and the Internet. He made his first splash while at Berkeley and tracked down some hackers breaking into computers in search of information to sell to the KGB. He wrote about it in 'The Cuckoo's Egg' and was featured in a PBS show about his year long hunt for the spies.

I also saw him more recently on PBS hawking this book.

Very dynamic and energetic hopping on and off desks. He's a very enthusiastic computer fan with increasing concern in using the WWW for education and communication. You can sense his ambivalence with his exultant discovery of something new and interesting on WWW, then a swing back with a realization of how little is actually useful.

Concerns:
cheapen actual experiences
undercut schools, libraries
medium oversold
spend too much on technical gimmicks teachers don't want
email is unreliable

Stoll gives an example of collaborating with a Chinese astronomer using a thousand year old set of not-too-reliable star measurements. They were looking for periodic motions such as that of the earth's north pole. The Chinese astronomer was using Fourier transforms calculated by hand! He used trigonometry tables and twelve abacuses. Stoll spent a couple of days writing a computer program to do the 'same thing.' They compared the resulting information and found some discrepancies. Stoll had spent time writing the program, while Professor Li had spent months not just doing the calculations but developing a complex method for analyzing the data taking into account the accuracy of different observers and other ambiguities. Of course a more elaborate program could be written to emulate this procedure. Would it be worth it? A simple data reduction program is straight forward. Writing a sophisticated data analysis front end program might require longer than analyzing the data by hand when you only have one database to explore. Or if a database program were used could you set it up to evaluate ambiguities accurately and correctly?

Stoll points out that the use of the Internet is heavily subsidized. A recent article pointed out that our phone system which is used by the Internet was designed for occasional 3 minute conversations. Increased heavy use by the Internet is causing some interruptions in service-soon to get worse unless massive upgrading takes place. This will probably be paid for by billing users of the telephone for actual usage. A crisis for anyone with teenagers as well as heavy users of the WWW.

Computer systems in different libraries tend to be quite different so mastering one in NJ may not help me in Arizona because it is not likely to be the same. What about looking up a reference only partly remembered? I can flip through the section in our card catalogue and target in quickly, very difficult to do on our computer system. Maybe yours is better, but if you use several libraries it is likely they are different with different commands, etc., and very likely to 'improve' over time. This requires you to keep up with the improvements even if you are doing the same thing.

Your friendly librarian also needs to spend time keeping up with newer techniques which detracts from time available for other functions such as helping patrons. Most libraries can't afford to keep up both the computer system and a card catalogue, so you use the new system or don't use any.

There are many examples of finding very interesting things on the Net. It's fun just exploring, but..."Our networks can be frustrating, expensive, unreliable connections that get in the way of useful work. It is an overpromoted, hollow world, devoid of warmth and human kindness.

The heavily promoted information infrastructure addresses few social needs or business concerns. At the same time it directly threatens precious parts of our society, including schools, libraries, and social institutions."

He's not negative on the Net, just some of the directions we're moving in and the potential consequences. When are we really learning and when is it just a diversion?

Stoll is quite impassioned about giving over libraries to using the WWW. Why not have students sit at home and receive great instruction from the finest teachers? One reason because home-study dropout rates are around 60%. The WWW can deliver information, but how to see interrelationships. Stoll doesn't think you can use computers to teach fundamental concepts like dimensional analysis. I've been using programs that help to do this very well for years. He feels that money would be better spent on smaller classes, and getting more support and respect from communities. How do you requisition this?

Too much multimedia might make straight reading much less practiced and attractive. A tendency not to think a paper through, because it's so easy to rewrite on a computer. Stoll feels that reactive thought which benefits from experience, such as pilot of a plane, is learned well on computers. Reflection where we hypothesize and work out solutions are more difficult to get from a computer.

An example from his own dissertation- simulating the atmosphere of Jupiter is interesting. He developed a model of Jupiter's atmosphere from '..a few spacecraft images, a bit of physics, and two years of number crunching, I was able to measure the size of ammonia crystals on a planet halfway across the solar system.'

Fascinating too he's not sure he believes his own model.

So we have a guy who loves computers, books, and learning. His ideal library of the future is the community library we have now. A problem is electronic storage not the media, but the reading equipment. Tried to buy a record player instead of a CD player lately? Other problems are with the ability to scan books and other printed media you can, but its not 100% accurate. By the way does anyone know of a scanning program that can read super and subscripts? Material might have to be replicated in a more modern format every twenty to thirty years-very expensive.

Electronic library searches are very effective if you want to find a specific book, especially if you can do it electronically from home or office. Electronic searches for connections between different topics are much less effective than card searches. Another problem is the myriad search systems used and changes made during 'updates.' ..."Even though I constantly use computers, I still have to figure out how to look up a book. I forget the commands between library visits. Every library has a different on-line system: my own library has three, all mutually incompatible. Their terminals have sticky keys. At the very moment I need the command menu, its scrolled off the top of the screen." Electronic books are definitely not the way to read a novel, but it's convenient to have reference material on-line.

We are shifting resources from books and librarians to on-line access to the computerized catalog of the Library of Congress. Of course you'd have to go to Washington to read the books. Perhaps its reassuring to know the book you want is there? Actual material form the Library of Congress is now becoming available.

He like many of us is finding it increasingly difficult to download information due to heavier use of available bandwidth. So increase the bandwidth (the amount of information you can push through) to take care of the increased traffic-sure just like adding highways cures traffic problems. Of course the electronic highway is much more amenable for a technology breakthrough, I'm already hearing of many possible solutions for adding increased capacity and speeding up existing infrastructure. On the other hand companies like Apple are coming out with software which will allow us to cut and paste color 3-d clips and send the resulting color 3-d movies over the WWW. So we're gong to need a lot of bandwidth. It should be an interesting unending race.

Book Review2- by Brian Pankuch

"Being Digital," by Nicholas Negroponte, 1995, Alfred A. Knopf, Inc. ISBN 0-679-43919-6, 247 PP, $23.00.

Nicholas Negroponte is a Professor of Media Technology at MIT, and Director of the Media Lab. He is enthusiastic about what increases in bandwidth will do. Bandwidth is the ability to send information down a given channel, whether copper wire, optical fiber, or as electromagnetic radiation. Fiber is especially impressive since we are already close to sending a trillion bits per second. Capable of carrying a million channels of television at the same time or all the Wall Street Journals ever printed in a second. That's a lot of information.

The book for the most part is a string of essays and articles done before and not particularly well connected. If you like his column in *Wired* magazine, you'll probably enjoy his book.

As one might expect he has been involved in many interesting projects. Asked to help ready our commandos for different hotspots, he set up a system for storing tapes of potential hotspots on videodisks which could give our antiterrorist commandos the computer equivalent of a drive down streets and corridors they might soon be fighting in.

He is inclined to go where the action is. People who are interested in applied research are reading the Wall Street Journal instead of scholarly journals. The action is in entrepreneurial companies so you're more likely to find cutting-edge information in the Wall Street Journal.

With the increasing inexpensive power available to use in computers Negroponte is strongly in favor of using it to improve our interface with computers and other electronics, and appliances. "....At home I used to have a very intelligent VCR with near perfect voice recognition and knowledge of me. I could ask it to record programs by name and, in some cases, even assume it would do so automatically, without my asking. Then, all of a sudden, my son went to college. I have not recorded a TV program in more than six years. Not because I can't. It is because the value is too low for the effort. It is needlessly hard.."

I could give the example of digital watches. When they first came out setting the correct time was awkward frequently requiring a pointed tool and each was different. Now the usual watch stem has the usual function.

Computers and systems in general will know you, learn about your needs, and understand both verbal and nonverbal languages. An example is the video tape of Apple's hypothetical Knowledge Navigator and its lifelike machine persona with the ability to be a prized, friendly, extremely attentive, well trained personal assistant. Speaking for myself I could use one right now. Apple's current version of Newton the hand held message pad is much improved over the first model. It is helpful but has a long, long way to go to be this intelligent assistant.

"The best metaphor I can conceive of for human-computer interface is that of a well-trained English butler. The 'agent' answers the phone, recognizes the callers, disturbs you when appropriate, and may even tell a white lie on your behalf. The same agent is well trained in timing, versed in finding the opportune moments, and respectful of idiosyncrasies. People who know the butler enjoy considerable advantage over a total stranger. That is just fine.... If you have somebody who knows you well and shares much of your information, that person can act on your behalf very effectively. If your secretary falls ill, it would make no difference if the temporary agency could send you Albert Einstein. This issue is not about intelligence. It is shared knowledge and the practice of using it in your best interests."

If you've experienced some frustration with keeping up with the tremendous amount of information we have available.
" ...Imagine a future in which your interface agent can read every newswire and newspaper and catch every TV and radio broadcast on the planet, and then construct a personalized summary. This kind of newspaper is printed in an edition of one."

Virtual reality has the interesting potential of making realistic simulations useful, allowing the user to practice rare and dangerous events without for instance wrecking a real airplane landing in fog in San Francisco. Clever breakthroughs will allow use of holograms without necessitating hardware that gives resolution of 10,000 times that of your TV. Holograms combined with devices that sense where you are looking will provide some very realistic simulations. Simulations where you are the molecule and "experience" what it is like to undergo a reaction, modeling of expensive or dangerous reactions and systems would be very interesting.

We are of course most interested in applying computers to learning. Rather than using computers just to shove facts into minds he suggests that one might learn about frogs not by dissecting but by building a simulation of a frog. Students could be asked to design a frog to simulate the muscles, etc. They are probably using computers more than the average professor, and writing and reading more with email than they are in science courses. I've been working on simulations myself and it is a great learning and presentation tool, but programs like Director take quite awhile to use effectively. This could be a very interesting project for upperclassman or students who have developed more computer expertise.

Back in 1981 a conversation with Sheik Yamani led to an experiment with two dozen Apple computers and Logo introduced to rural, poor Senegalese children. These children showed no difference in adoption or enthusiasm than American middle-class children, they loved it.

Negroponte foresees the probability of having machines and appliances communicate with each other and us. Your computer or VCR will be able to instruct you on how to do a set of operations to accomplish your goal. Microsoft is already including Wizards to help graph, etc. Apple has the Apple Guide for its Macs and quite a bit of built-in help for its Newton.

The way we do science and medicine has changed dramatically over the last century. In a typical classroom there is little difference in how we are teaching now versus one hundred years ago. Pursuit of intellectual achievement will cater to a wider range of cognitive styles, learning patterns, and ways of expressing ourselves. Work and play will become less distinct using the same tool-computers-for both. Negroponte is very optimistic about this amount of power being in the hands of the young, despite much additional competition and challenges from all over the world.

This book is an interesting read. More material specific to learning would have been helpful, but sharing the vision of someone helping to shape the future and using the latest innovations is sure to spark some ideas of your own.

Brian Pankuch

General Chemistry Classes Held in the Computer Lab

by Carolyn Sweeney Judd, M.A., Chemistry Faculty
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September 25, 1996

ABSTRACT: As a follow-up to a paper given at the 14th Biennial Conference on Chemical Education at Clemson University on August 5, 1996 (Creative Combinations: Chemi-Skill-Bildr and PowerMacs), we would like to detail a typical session in our computer lab. Our commitment is to be present with the students, making computer time an integral portion of the lecture - not simply an add-on, to be done by students on their own time. Our commitment grows out of two things: that students can do good group work, with one of the members of the group being the computer; and that very good tutorial and individualized homework programs are available for prices that make them accessible for our budget.

Envy started C. Judd on the path now followed. It started over 5 years ago with a visit to an introductory computer science lab, watching the intensity of the students, listening to their collaborations, and observing their reluctance to leave at the end of a 3- hour class. In contrast, at the end of the 3-hour general chemistry lecture, students appeared only too glad to stumble out of the room. C. Judd wanted some of that vitality for her classroom, and became determined to find a way to include computer time during the lecture time.

At first, when going to a computer environment for part of the lecture time, we looked for facilities that would allow one student per computer for an individualized homework program shared with Houston Community College System by the University of Texas at Austin (Project SHARE was underwritten by a Summer CATALYST Grant, May, 1993.) C. Judd was given a special section that was limited to 20 students, because that was the number of computers in the available computer lab. But then we noticed that the real learning was taking place when students leaned toward each other, sharing problems, questions, and solutions. We realized that the silence was not good — that a lot of noise meant that a lot of sharing was going on. And that the sharing was the best way for learning for beginning students. Our conclusion was that one computer per student is neither necessary nor desirable.

In the fall of 1995, we acquired our new physical science computer lab, with 12 PowerMac computers, equipped with DOS cards. We chose these particular computers because over the years, we had built up a reservoir of favorite software for both PC and Mac computers. In fact, we spend much effort trying to maximize the use of the computer lab while getting the most value from our computer budget. However, many faculty members, different classes, and various software packages all in the same lab are components for chaos. We have found that a well-versed student computer specialist is vital to the smooth operation of the physical science computer lab. Our computer lab has been running relatively trouble-free and virus-free.

One-third of the lecture time is now spent in the computer lab. We do not cover issues twice; the computer lab is not redundant. Computer tutorials cover concepts that are well done with available software. - e.g., nomenclature, gas laws, stoichiometry, and drawing Lewis structures. We use several programs: "Introduction to General Chemistry" by Stanley G. Smith and Ruth Chabay (Falcon Software); "Chemical Bonding" by Gordon Galloway and Paul Hunter (Falcon Software) , and "SIRs" by John Martin (JCE:Software.) At the same time as we opened our new computer lab, we began to use the individualized homework program, "Chemi-Skill-Bildr" by Jim Spain, furnished to each student on a floppy disk. Students are responsible for their own homework, but we encourage collaboration by having students work together on one student's disk during the computer lab time. Because "Chemi-Skill-Bildr" also includes short tutorials as well as the homework problems, we often use this program.

Both the instructor and the student computer specialist are always with the students during the computer time, re-enforcing that this is not an add-on to the course, but an integral part of the lecture. Moving from one student group to another, we are able to address questions that are pertinent to that group. The result is that we focus our time on actual student problems. When we find that several groups do not comprehend a concept, we computer specialist addresses any computer issues, and also serves as a student tutor for chemistry.

The result is that we have students who talk about chemistry, discuss and even argue about chemistry, and become active learners. For classes which include many foreign-born students, this vocalization and activity would not occur if recitations before the class were demanded. C. Judd is no longer envious of that computer science class, for her classes are now places of visible learning also.

Our method could be easily modified for other colleges. Because several students can use one computer, hardware costs need not be large. The advent of excellent tutorial programs over the Internet lowers the costs of software acquisition. Also very good software is commercially available at modest costs. For many institutions, group work with a computer as a member of the group can be an excellent way to engage students' minds in active learning.

HyperChem in the Physical Chemistry Laboratory

David Whisnant
Wofford College, Spartanburg, SC 29307

HyperChem is a molecular modeling program that runs on a variety of platforms, including a Windows 3.1 or Windows 95 based PC. The version we use at Wofford (HyperChem, Release 3) includes several molecular mechanics and semi-empirical molecular orbital methods. A more recent version also includes ab initio calculations. We have three copies of HyperChem available, two on 66 MHz 80486 machines and one on a 75 MHz Pentium, which we use in our general chemistry and physical chemistry laboratories.

In physical chemistry, my students use molecular modeling in two experiments. The first is an addition to a traditional experiment in which the students record the visible spectra of three conjugated cyanine dyes (e.g., Shoemaker, Garland and Nibler, 5th Ed., pp 440 - 446). They obtain the wavelengths of maximum absorbance from the spectra and calculate the photon energies corresponding to the transitions. These energies can be fitted to a particle-in-a-box model and used to estimate average bond lengths for the molecules (Moog. R. S. J. Chem. Educ. 1991, *68*, 506). At the end of this experiment, my students use the MM+ molecular mechanics option in HyperChem to calculate an alternate model of the smallest dye molecule. They then use the ChemPlus extensions for HyperChem to vary the torsion angle between the two ring systems in the dye. The molecular modeling calculations add around an hour to the experiment when the program is run on the 75 MHZ Pentium and somewhat longer on a 486 machine, mainly because of the time required for the torsion angle search. The bond lengths obtained from molecular mechanics and the average value estimated from the particle-in-a-box model differ by less than 1%. They also are within 4% of the bond length in benzene.

Small carbon clusters have been of considerable interest in the last decade, due to their relevance to interstellar and combustion chemistry, and because of the synthesis of the fullerenes. Our second physical chemistry experiment involving molecular modeling is a semi-empirical MO study of the C_5 molecule, based on the description of such calculations in Weltner and van Zee, Chemical Reviews 1989, 89, 1713-1747. The students begin by using MINDO/3 to calculate heats of formation for several possible C_5 isomers — linear, pentagonal, trigonal bipyramidal, square pyramidal, trapezium, and tetrahedral. They then use the heat of formation values to predict that the linear structure is the most stable.

Having decided that the linear structure is the most stable form of C_5, the students then use PM3 calculations to make predicions about this isomer. They find that the calculated bond lengths are around 1.28 Å, consistent with the model :C=C=C=C=C:. They calculate the energies of the molecular orbitals and use contour plots to draw pictures of the orbitals, to which they assign , , and inversion symmetry labels. They also calculate the wavelengths and oscillator strengths of the three most intense visible-UV peaks, as well as the wavelengths of peaks in the IR spectrum. These predictions can be compared with theoretical and experimental results in the literature.

The C_5 computational chemistry experiment, on which the students work in pairs near the end of the second semester, is useful because it ties together several topics which we have discussed in lecture throughout the year. First, it gives the students experience with a practical application of molecular orbital theory, which I find it difficult to cover effectively in lecture. The students also make a brief return to thermodynamics (which they have learned in the first semester) when they use heats of formation to predict the most stable isomer. They use group theory to identify the point groups of the six C_5 isomers and apply symmetry to label the different molecular orbitals. The predicted oscillator strengths of the visible-UV peaks lead them to discuss allowed, symmetry-forbidden, and spin-forbidden transitions. Finally, HyperChem shows animated pictures of the vibrations corresponding to the infrared transitions. This gives the students the opportunity to think about vibrational modes and the relationship of changing dipole moment to the intensity of the transitions in the infrared.

"Learning Networks:
A Field Guide to Teaching and Learning Online"
by Linda Harasim, Starr Roxanne Hiltz, Lucio Teles and Murray Turoff
The MIT Press, Cambridge MA, 1995
ISBN 0-262-08236-5 $ 35

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This book considers the use of computer networks for educational activity in primary, secondary, university, and adult education. It indicates how this new technology can strengthen and transform teaching and learning practices, opportunities, and outcomes. It describes some of the advantages and pitfalls of network-based learning compared to traditional classroom techniques. The four authors have been actively engaged in online learning and describe their personal experience as well as providing information from a variety of online and published sources.

The book is 329 pages in length and consists of three sections, eleven chapters and seven appendices as well as eleven pages of references, a table of contents and an index.
The sections, chapters and appendices are:

Here are a few selected quotations from the book:

"The traditional face-to-face classroom learning situation is generally assumed to be the best to support learning, with other learning modes perhaps perceived as less effective. There is no evidence to support this assumption. In fact, quite the opposite is true: Online environments facilitate learning outcomes that are equal or superior to those generated in the face-to-face situation."

"The asynchronity of online interactions allows participants time to reflect on a topic before commenting or carrying out online tasks. ... "

"In research on online ... courses ..., students identified the following benefits ...:

Increased interaction: quantity and intensity
"... I've never been involved in a course in which I've learned so much from other students. This was because there was no competition for the floor and therefore everyone was able to have her say. Also, as remarks were all documented, they were subject to more in-depth consideration than in the normat classroom."

Better access to group knowledge and support
"The information exchange is more diverse in that input is coming from everyone rather than only from the instructor."
"I learned much more than in a regular three-hour course because of the interaction of all the students in the course. It is much more enriching this way. Through this medium we could tap the combined knowledge of the group."

More democratic environment
"In online discussions, I think that there is a

tendency to respond to content rather than to personalities."
"Conferencing as a course vehicle promotes more equal interaction among participants, dropping barriers ofgeography, urban/rural styles, social skills, mannerisms."

Convenience of access
"I find myself thinking about the ideas in the online class more because there is no three-hour limit of class time."

Increased motivation
"I am cold. I need to clean my lenses and I am thirst. Yet, I'm still here. Know why? This is better than TV - the anticipation of a good show, great cast of characters, fast-moving plot, thought-provoking and, like a serial, the end is not in view.""

Active Learning
"Active learning is a major outcome ...
Participation is based on making input, responding to peers, and sharing ideas. ... Those who read but do not comment are sometimes referred to as "lurkers", and others ... are likely to cajole or encourage lurkers into active participation. Teachers may allocate a grade for online participation, thereby providing incentives and acknowledging student effort to learn the system and formulate a comment.
Active participation strengthens learning. Putting ideas or information into written form requires intellectual effort and generally aids comprehension and retention. ...
Because online learning communities are always open, there is a wide opportunity to participate and to refine and reflect on ideas. In the traditional classroom, only one person at a time may speak, and many people who would like to contribute are never called on. In the online environment each student can comment whenever he or she wants.
Moreover, ideas can be developed interactively, over time. ... This expanded access to learning peers and activities encourages reflection on ideas and building of knowledge."

Collaborative Learning
"Collaborative learning refers to any activity in which two or more people work together to create meaning, explore a topic, or improve skills. ... With Computer Mediated Communication, practically all course activities can be designed as collaborative activities. Through formulating information or ideas in their own words, and receiving feedback and evaluation on these formulations from peers, knowledge,
thinking skills, and meaning are socially constructed. ... In designing an online course, the creative challenge to the instructor is to rethink the syllabus in order to build in as many collaborative activities as possible. ..."

Learning Communities
"The community that forms among network users can be both personally and educationally enriching. Many people who enter a learning network for the first time fear they will find an impersonal, dehumanized space. The social reality of the environment frequently comes as a complete surprise. The communication flows enabled by the networks bring friendship, comradeship, intellectual stimulation, and personal satisfaction. Friendships are formed as the network becomes a "place" to share insights and concerns, problems and solutions, enthusiasms and fears. ..."

"The predominant application of school-based networks are based on curriculum enhancements; networks thus serve as a supplement or adjunct to regular instruction. This approach, referred to here as adjunct mode, is also the most common in university and distance education networking activities. However, two additional modes of networking are also widely used in postsecondary courses: mixed mode, in which a significant portion of a face-to-face or distance education is conducted by email or computer conferencing, and totally online mode, in which the network serves as the primary environment for course discussions, assignments and interactions."

Adjunct Mode
"Adjunct mode use of networks allows students to communicate with instructors and other students outside normal classroom or office hours for such purposes as extending opportunities for class discussion and debate, increasing access to instructors, submitting and/or exchanging class assignments, enabling group tasks among students in the same classroom or in a networked classroom approach, and expanding opportunities for informal group discussion and social interaction. . . . Networking also introduces opportunities for learner-learner interaction and collaborative learning approaches in distance education. . . . Computer networking lets us all talk to each other when we're feeling our best, and it allows teachers and students to speak freely without

allows teachers and students to speak freely without the restrictions of age and power differences that sometimes arise in an office.
Computer conferencing systems have been found valuable for such adjunct mode activities as electronic office hours. Many questions are of interest and relevance to the whole class, and the use of a conference for open class discussion avoids duplication of effort for the professor. Sometimes students assist one another . . . Instructors use email and computer conferencing for distributing class outlines, supplementary notes, handouts, instructions, assignments, test questions, and, sometimes, administering tests and quizzes."

This book is of interest to those educators who are interested in online learning. I recommend it.

INFORMATION ABOUT AND EVALUATION OF THE SPRING 1996

ON-LINE INTERCOLLEGIATE COURSE

"ENVIRONMENTAL AND INDUSTRIAL CHEMISTRY"

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I. INTRODUCTION

The on-line intercollegiate course is described in the Spring 1996 issue of the "Computers in Chemical Education Newsletter" pages 17 to 20. 104 students from 22 schools registered for the course. Due to computer problems six students who registered from Nanyang University were not able to participate.
The on-line segment was common to each of the courses, but instructors at each of the participating schools had autonomy in determining what activities were expected of their students, how grades would be assigned and how the course was to be structured.

In order to obtain a better understanding of the different courses, an information and evaluation form was sent via e-mail to each course student. This article summarizes information from 49 of the 98 students at 17 of the 21 schools. Many of the student responses are quoted in unedited form. (Some quotes were edited. Some student responses are not included in this summary.)

Additional information about the course can be found on the World Wide Web site:
http://dirac.py.iup.edu/college/chemistry/chem-course/webpage.html
In addition, this issue of the Newsletter contains an article by James M. Beard, chair of the course organizing committee with some comments and analysis of the 1996 on-line course and some suggestions about future on-line courses.

II. SUMMARY OF INFORMATION AND STUDENT RERSPONSES

A. About the Students
71 % were seniors
24 % were juniors
2 % were sophomores
2 % were graduate students

51 % were chemistry majors
10 % were biochemistry majors
14 % were physical science majors
6 % were science majors - chemistry emphasis
2 % were environmental chemistry majors
6 % were environmental science majors
10 % were biology majors
2 % were construction engineering majors

B. Course Title:
59 % of students registered for "Environmental and Industrial Chemistry"
23 % for "Special Topics in Physical Science"
10 % for "Chemistry on the Internet"
3 % for "Advanced Topics"
3 % for "Independent Project"
3 % for "Readings in Chemistry"

67 % of the students registered for a 3 credit hour course
31 % for a 1 credit hour course
2 % for a 2 credit hour course

Course class size varied from 1 to 13.

C. Course Descriptions
From analysis of the information questionnaires it was obvious that different instructors had very different requirements for their students.

1. Before the On-Line Segment

Generally, two or three weeks before the beginning of on-line student activities, In this initial period students became familiar with their e-mail system, the World Wide Web and signed onto tho Listserv OLCC-STU discussion list. One instructor had his student view a videotape which he had prepared on the use of the computer, software and the Internet. Some students reported 7.5 hours of class meetings each week during this period. In another case one half-hour organizational meeting occurred at the beginning and after that students and groups of students operated autonomously, but the instructor was available for consultation.

2. On-Line Segment

During the on-line segment students were expected to read the three papers written by industrial chemistry experts and two student papers which were selected by a committee of instructors. About two weeks were devoted to the discussion of each paper. Students monitored and participated in the on-line discussion. Students asked the authors of papers and other students questions and generally contributed to the on-line discussion. Students spent from 0 to 4 hours per week in class. In some instances background material was presented in class, questions were asked and discussed. In some cases questions were formulated and revised prior to sending them to OLCC-STU. Also, author's responses to questions were examined and discussed in class. In at least one course additional assignments were made in class. There were in-class quizzes in at least one course. Time was devoted to the selection and writing of a group paper in some courses. At one school students were asked to prepare a group paper and also an individual paper. In one case only one student participated. She met with the instructor when she had questions or a problem. Most of the communication between the student and instructor occurred via e-mail.

Some instructors required each of their students to keep a journal of electronic mail transactions, questions, research, a summary and analysis of the papers. This journal was turned in at the end of the course. Other instructors had no such requirement. One instructor required a short report on a herbicide, fungicide, rodenticide or pesticide. Some instructors discussed research and the preparation of papers. One instructor assigned and discussed articles dealing with critical thinking skills. Another assigned additional readings on ozone depletion. Another instructor required students to read a considerable amount of additional material and answer detailed questions. Some students were asked to make formal presentations in class. A number of major environmental problems were identified by one class. A broad overview of industrial chemistry and relevant environmental laws was considered in one course.

3. Post On-Line Segment

Most of the participating schools had 1 to 3 weeks of the semester left after the on-line discussion of papers. Some schools held no class meetings after the conclusion of the on-line segment, and others devoted 1 to 9 hours of class time. Some classes summarized and tried to integrate the diverse topics discussed on-line and in the classroom. Summary papers and final papers were completed. In one case additional time was used for further discussion of environmental issues and of scientific ethics. In another case there were tests and at one school there was a final examination. At another school students turned in a portfolio, poster and research paper.

4. Student Papers

80 of the students prepared a paper for their course. Most papers were group efforts involving from two to twelve students. A list of suggested topics was distributed by a committee of instructors at the beginning of the course. In some cases the course instructor suggested a topic or topics. In one case, the World Wide Web and other Internet resources were used to determine which topics would have abundant research information. Three or four topics were identified and one topic was selected. In another instance the class listed possible topics on the board. The list was narrowed to two topics. A search was made to determine how much information was available on these two topics and the topic was selected by class vote.

The titles of some of the papers were:

1. Vitrification of High Level Radioactive Waste at the West Valley Demonstration Project
2. Superfund: Expanding Opportunities for Lawyers, Chemists and Bulldozers!
3. An Assessment of Reformulated Gasoline
4. Three Mile Island: Tragedy or Warning?
5. What Happens When You Harness the Atom: Evaluating Current Disposal and Storage Options as Well as Today's Environment
6. Methyl Bromide

7. DNAPLS and Ground Water
8. Bhopal: The Disaster and the Aftermath
9. The Bhopal Incident and Its Effect on Pregnant Women
10. Stratospheric Ozone Depletion: Why it is an issue?
11. Bioremediation
12. The Destiny of Plastics
13. Recycling Plastics
14. Biodegradable Plastics - A Cure for a Consumer Society
15. Love Canal: An Overview of the Toxic Waste Dump That Brought the Chemical Industry to Its Knees
16. Study of an Industrial Accident
17. Effects of Toxins on Tributaries of Lake Erie, Buffalo River and the Niagara River
18. A Summary of the Clean Air Act as Amended in 1990
19. Warfarin - How to Build a Better Mousetrap
20. Risk Assessment of Toxic Chemicals: The EPA Regulations and Procedures
21. Study of Chemical Fire and Subsequent Chlorine Release

D. Summary of Additional Student Responses

1. Distribution of Papers Via the World Wide Web

Was the format of papers as they appeared on the WWW satisfactory?
46 responses - 93 % WWW satisfactory
7 % WWW unsatisfactory

2. OLCC-STU

This Listserv was designed to provide interaction between authors and students, and between students. Students used this to ask questions of authors, authors used it to answer questions and perhaps to ask questions of students. Also, OLCC-STU was used for discussion.

Was the operation of OLCC-STU satisfactory?
47 responses - 96 % OLCC-STU satisfactory
4 % OLCC-STU unsatisfactory

Did you use the digest or mail mode?
40 responses - 95 % used mail mode
5 % used digest mode

3. On-Line Questions and Discussion

Did you find the scheduling of questions and discussion to be satisfactory?
44 responses - 82 % scheduling satisfactory
18 % scheduling somewhat unsatisfactory

4. Some Evaluations

Evaluation scale 1 to 5 -
1 is Poor, 3 is Average and 5 is excellent

a. Overall evaluation of on-line segment of course —
Average evaluation = 3.93, S.D. ave. = 0.11, n = 47

b. Overall evaluation of OLCC-STU questions, answers and discussion —
Average evaluation = 3.86, S.D. ave. = 0.10, n = 48

c. Overall evaluation of course —
Average evaluation = 4.13, S.D. ave. = 0.10, n = 46

d. Best Paper
43 responses - 60 % rated one of the three Expert papers best
The average rating from those who rated the paper best was 4.5.
40 % rated one of the two student papers best
The average rating from those who rated the student paper best was 4.4

e. Best Discussion of Paper
36 responses - 45 % rated discussion of one of the Expert papers best.
The average rating from those who rated the discussion best was 3.9
55 % rated discussion of one of the student papers best.
The average rating from those who rated the discussion best was 4.5

f. What Liked Best About the Course
1. All the information on the WWW and different insights by different students
2. This was the first time I could actually direct questions and comments about an article to the author.
3. Opportunity to communicate with a class of my peers from around the country
4. Expert papers
5. I enjoyed learning about things which are going on in our world today.
6. The direct contact between writers of papers and students

7. Convenience of meeting time, interacting with students who have had different backgrounds in chemistry
8. Additional computer and Internet experience - vast amount of information out there - Freedom to come and go when you feel like it
9. I could ask the authors questions.
10. Being able to discuss these questions with students from different parts of the country
11. The ability to utilize technology in a created learning environment
14. Wide range of questions, get to ask questions
15. Reading the papers and the background information presented in class - Class discussions - Learning to use the Internet
16. being on-line and having discussion with students across the country - I liked that this class was not too technical even though it was a chemistry course.
17. Freedom to participate as much as I wanted - I liked preparing our own paper on a topic we chose, and the learning experience of the Internet.
18. Reading the expert and student papers
19. Being able to question something an author wrote and getting feedback - As well as reading other people's questions and comments
20. The opportunity to ask questions of the authors and to become familiar with the Internet
21. The fact that I could see how other people reacted to the same materials that I read.
22. I liked the points raised by the other students when a question was answered that didn't coincide with the information in the paper.
23. The papers themselves
24. Liked the on-line portion
25. The web sites used and the topics of the papers
26. Learning more about what goes on in the industrial world
27. Interacting with a new media for educational purposes
28. The in class discussion of the on line papers
29. I enjoyed the way that this class functioned. Everyone was responsible for keeping up with their e-mail and reading assignments (papers). The discussions were very thought provoking. These discussions helped me focus on some important concepts in chemistry.
30. Information
32. The mixture of student and expert papers
33. Flexibility
34. Using the net, having access to such a diverse group of people, background reading for the papers and the papers - that there was a group of experts willing to take the time for the on- line course
35. Accessing the Internet
36. The fact that I was able to look at how many of the chemical techniques I have learned are applied in real life situations - The fact that I was able to go into the web to research topics without going to the library - The fact that there was not the restriction of a classroom - The fact that it incited an interest in finding out more about the topics
    - As for the course itself, it showed me the application of chemistry to the real world - I also enjoyed looking at the fact that even science requires tolerance and emotional distance. For the chemist, this may mean adapting to a changing world by combining progress for man's happiness with necessities of his security. Above all, I enjoyed the trust that my professor had in me by allowing me to explore the topics independently, and the fact that he showed extraordinary patience with me as I familiarized myself with the computer system.
37. Opportunity to see what is really being done in industry, learn to use the Internet and "talk" to students at other schools
38. Learning to use the Internet as an educational tool and a reference source
39. Learning to use the WWW, as well as getting e-mail
40. I liked using the computer to find out new and exciting information.
42. The ability to get feedback from students all around the country
43. Getting involved with others that I normally would never interact with
44. The interaction between people in industry that deal with chemistry and the public every day and the educational world that deals with chemistry in the purist form
45. Hearing the opinion of other students
46. I liked the interaction that was able to occur, sometimes within minutes.
47. To be very honest I enjoyed doing the research via the Internet. Even when our group was answering a question it was fun to go looking for the information. It was also kind of novel that we were participating in a class nationwide.

g. What Liked Least About the Course

1. Volume of mail
2. Being overwhelmed with e-mail messages every morning
3. Being in a room with 120 students all talking at once, the net effect of the mailing list segment of the course, and the poor participation of the faculty of this university
4. Trying to send messages (never learned to do so)
5. It took a lot of time
6. Discussions seemed off topic for a chemistry course
7. Time-consuming to sort through messages - more organization/ better method of identifying the content of the message in the subject line
8. Frustration with local computer system
9. Handling the mail
10. Computer glitches
11. Plodding through hundreds of mail messages
13. Only one credit hour for the amount of reading
14. Waiting for answers and losing them
15. Format of the messages - Too much garbage before and after body of the message
16. I found it hard to sort through the messages in the beginning because the format for the subject line was not followed. Also, the way the responses from author were formatted made it difficult to match them to the appropriate questions. The 2nd and 3rd e-mail sessions were easier to manage.
17. The constant flow of information through questions and answers was a little overwhelming at first.
18. Discussion of the student papers
19. Not much discussion between students
20. Topics too specialized, the volume of messages was too much to handle
21. People should have been clearer and more concise with their messages.
22. The many messages I received every day!!!!
23. Most of the student postings
24. Nothing except this evaluation of the course
25. Keeping up with the number of messages
26. The large number of questions for the first paper
27. Confusion over technical difficulties
28. On-line questions and comments
29. The hardest part of this course was finding the time to read my e-mail. Another problem was the high volume of mail.
30. Lots of messages
31. The lack of technical information forthcoming from some of the authors
32. There was not enough time for each paper.
33. Problems with returning my messages
34. The format of the on-line answers and questions - As mentioned earlier, a consistent format as suggested should be used right from the beginning to make it easier to sort and put into perspective.
35. The duplication of questions . . .
36. There should have been more time between papers for questions, answers and comments.
37. Jumble of topics and messages - hard to remember what the answer was in response to sometimes and what has already been said
38. The volume of e-mail messages (Were some students graded according to how many comments/questions they posted? If so, that's a bad idea; it adds to unnecessary traffic on the list.)
43. Too many messages about too many seperate topics
46. At first, all the information was very overwhelming and a little intimidating.
47. I found it hard to use my e-mail account for what I had been using it for. I could no longer use it to communicate with friends or family.

h. Advantages of On-Line Courses

1. Different views from all over the country - Contact with individuals, such as industrial chemists, that we would not get in the classroom setting
2. Work can be done at my convenience rather than during the scheduled class time.
3. Wide range of input
4. Can access information and other student's thoughts from all over
5. The computer has basically all you need - No running around, etc.
6. Fast, inexpensive communication
7. Access to experts
8. Develop your own analytical thinking skills - The freedom to work at your own pace
9. Can ask questions of the authors - Discuss papers among students
10. There is a broader base of people discussing topics - you might not find this in the normal classroom.
11. It allowed students from diverse backgrounds to discuss topics with experts in their fields.
12. A lot of topics
13. Variety of issues
14. It can offer students the opportunity to take courses not offered at their home university. Explorations on WWW
15. Wider variety of comment, opinions, concerns, issues raised, ideas presented

16. I have a home computer and was able to access my messages from home. I had an advantage over my classmates. Additionally, I like the non- traditional atmosphere of this type of course.
17. To learn practical issues addressed through chemistry in industry and the use of the Internet
18. Many points of view
19. Learning about other places, e.g. Love Canal - I would never know about it otherwise.
20. Opportunity to interact with students outside our college and improve Internet skills - Also, this type of course, if run properly, would reduce the amount of paper used in class. I could work when it was convenient for me (outside of class time).
21. One can learn a lot more from group discussion of a paper/topic then from reading texts and articles alone.
22. Working with computers and the WWW and such things will help me in the future with my career and research opportunities.
23. The ability to ask questions directly to the world's experts in various fields.
24. More people with diverse opinions and open minds
25. Easy communication of both students at my college and other ones
26. It gives students a chance to interact with other universities and to learn how businesses, laws and industry work together.
27. Broad and immediate interaction with other students and scientists
28. If we had a serious question the authors of the papers could respond or suggest further sources
29. The biggest advantage of on-line courses is the ability to communicate with others. In this course we were able to communicate with students from different states and other countries. Another advantage was the uniqueness of this course and the computer skills that were taught by this course.
31. The students are able to answer each others questions
32. The ability to have discussions with students from other universities
33. You don't have to be in a classroom environment and very advantageous to handicapped people
34. The number of people and variety of opinions
35. Learning from other people who had other sources to access
36. It allows one to learn about the Internet and become more adept with computers.
37. Very new material and access to new ideas
38. It's great to be able to get input from other students at other universities in these discussions. This gave me views from some perspectives that my class here at Samford might have never considered. Having access to discussion directly with the expert authors was also a great advantage which would not be found at most individual universities. Also, students can access the information via the web-page whenever needed.
39. Ease of communication
40. The fact that I can get on line whenever I want
42. Being able to get responses from not only specialists, but input from students as well
43. It is very nice to have almost instant access to people.
44. The interaction with people across the world about subjects that effect people differently around the world
45. Interaction with other students and reading articles that were of interest
46. It was a fresh approach to learning. It was not like any paper/pencil class. I also believe that I will remember discussions that we have had in this course a lot longer than the information I get from the traditional class.
47. I feel that this allows students to look at each other and ask questions. I do not believe that the computer is a substitute for actual in-class learning. However, I would have never learned any of the material covered in this class in a real classroom.

i. Disadvantages of On-Line Course

1. Mail volume, no uniform course requirement - Lack of face-to-face communication
2. Lack of person-to-person communication
3. Little real instructor involvement, I learn from listening, not from reading and taking notes
4. Not a lot of face-to-face interaction
5. It took a lot of time
6. Lack of computer literacy may hinder participation
7. Sometimes questions fell through the cracks, often the discussion seemed disjointed.
8. It would have been beneficial to meet once every 2 weeks just to briefly discuss each paper with the group and talk about problems or concerns.
9. Too much mail - Not everyone may prepare for discussion to the same extent.
10. Sorting out all the mail
13. scratching the surface of the issues
14. lack of direct interaction

15. Message format - needs work to make it easier to follow threads
16. Text only computers were a real disadvantage. Sometimes, after discussion of a paper had ended, I would realize that I had a question, but it was too late to post it - but that was the exception.
17. Having students participating who are not chemistry majors - This is not to say they should not be permitted to take the class, but maybe they should have looked a little more into chemistry issues before asking a question that could have been answered from most textbooks.
18. Immense amount of mail to read
19. Not really knowing people you are discussing things with
20. Lack of face-to-face communication
22. The jumping around between papers and the end of one and beginning of another
23. The inability to get immediate feedback
24. Lack of direct personal contact
25. The scientific backgrounds of the students varied
26. A large amount of mail each day
27. Difficult to organize
28. Debate via e-mail I find a real step backwards - The discussion is hard to follow and I lose interest in a debate over several days.
29. The biggest disadvantage would be waiting for replies. Sometimes a response would take up to four days while others were out within the next day. This slow response time broke some of the discussion threads.
30. Time consuming
31. Significant time is necessary to prevent all messages from being a big garble.
32. For the number of papers there was not enough time to fully discuss them.
33. Severe thunderstorms
34. The jumble of messages made it more time consuming than expected.
35. Not being able to talk face to face
37. Never getting to meet your classmates
38. Not all students participate as fully in on-line discussion as they might in classes at their own schools. This also might be helped by smaller discussion groups.
39. Confusion
40. There was not a formal class meeting. It took me a while to get used to this.
42. The fact that it takes a few days to hear the responses from the experts.
43. Schools with sub-par computer systems 44. Not being able to see the people on the other end of the computer screen and their body gestures and tones of voice that add a lot to a question or answer - I think that the absense of these things can lead to a lot of misunderstandings and doubts of questions and answers.
45. There really didn't seem to be enough time and effort, on my part, to research each topic more so that I could ask questions - we did not meet with our class.
46. — BOOKKEEPING! It was hard to keep up with all the information at times. It did help when we got to know each other, and began using abbreviations like "CAM-C- . . ."
47. It relies upon instruments like computers to be stable enough to have constant communication. It also has very limited abilities. For example, this set-up would never allow for more students than there already are. Imagine what it would look like if 200 people were submitting questions.

j. Suggested Changes to Improve

1. Make a uniform course requirement like at least one semester of organic chemistry so students are approximately on the same level. Do not increase the class size. I think the size and mail are somewhat manageable.
2. Choose more generalized paper topics which students already have an idea about, or at least have a general concern about. Have a better way (which is followed) to title the subject line so all the mail doesn't have to be looked through in order to find an answer to a specific question.
3. Well, I seem to be in a minority here. I've never been one to let that stop me though. While I found the course to be right on as far as discussion materials and the level of interest go, I think that the forum was poorly chosen. The implementation of a list-server environment created what was to me a hectic jumble of messages where often the point of replies and the train of thought was lost because there was little to make them coherent. This is, by no means, a fault of the persons writing. What frightens me is that I am fairly experienced with electronic communication. I can't imagine the impression the course might have had on those less experienced with the Internet. To lend a positive light to this, what the directors/coordinators of the course might consider would be using a Telnet accessable news reader/group to support the input side of the course along

with a mailing list for messages and administration. The use of a news-server rather than a list-server would allow students and faculty alike to access the discussions in an easy to follow threaded form from either a newsreader they are used to, or via Netscape's news feature.

5. The volume of questions should have been further reduced. That way we could have concentrated on a few topics in depth rather than having an unorganized discussion about petty discrepancies.
6. Use bulletin board format
7. Perhaps Newsgroup rather than a Listserv
8. Meet every two weeks
9. Require authors to ask questions of students, as a teacher would in class.
11. Make the discussion some kind of bulletin board.
12. No changes
14. Response techniques improved considerably - use more student papers
15. Message format
16. I would reduce the number of papers to 4 (instead of 5) so that discussion sessions would last longer. I could have contributed more if there had been more time.
17. Some way of controlling the amount of mail - Our server went down at times and when it came back we were swamped with messages.
18. Decrease the group size and cut out a student paper.
19. Schedule time for students to have discussions with students.
20. Choose papers that are written with us (the students) in mind. Papers with topics that generate discussion. Find a way of organizing the messages, not all need to "hear" every question asked.
21. Maybe break the students into groups on different Listservs.
22. Stricter codes about subject headings and discussion times.
23. I would recommend that all students be asked to read a certain set of materials before beginning the on-line discussion. That way, they can identify the relevant points of the on-line paper that is to be discussed, and know something about the topic before they approach it. This would generate better discussion.
24. It was a good course. The only change I would make is to have to a more expanded mail account at the individual colleges for the students.
25. Only to place more guidelines on the questions and make sure the schedule for all colleges is the same.
26. I don't know if this is possible, but it would be nice to organize the questions based on topics.
27. For my particular course, I would have enjoyed a few lessons on the use of the Internet at the beginning.
28. Concentrate more on in-class discussion and less on discussion on-line. If the overall purpose of this course was to familiarize us with the Internet maybe have students write papers using sources found on the Internet. Not only would this give students practical experience using the Internet, but students would be forced to discriminate information from the Internet because of the often unknown or unreliable sources putting it on the web. I feel this is a good experience in itself since we so often believe anything we hear especially from the media and in the area of science they are often misleading if not wrong.
29. Smaller groups might be one way to improve this on-line course. Less expert papers and more student papers might also improve this course.
30. None
31. some more effective way of sorting the postings than the abbreviations in the subject line
32. Have fewer papers that are more detailed
33. A handout perhaps
35. Instead of only papers, perhaps a real life problem (fairly simple one) from an industry to solve. Even if they already had the answer.
36. There could have been more time for each paper so that more time was allowed for the questions, answers and comments.
37. Assign background reading first, before on-line portion.
38. . . . the coursemasters might consider adding an additional expert paper to the course.
39. Some people have suggested a newsgroup, but I am not really sure how that would work. I think as long as everyone is clear in the subject line of the message which paper they are responding to, and if it is a question, answer or discussion, things will be okay.
40. A little more interaction with a professor on campus.
44. Some way for faster and more frequent interaction on questions and comments.
45. Maybe more class meetings.
46. I can't really think of any.

47. More time for questions to experts. I also feel like there was five weeks wasted for us here at MWSC. It would also be nice if there was more time to write student papers.

k. Additional Comments

1. I enjoyed the class
3. Overall, I do feel that I benefitted from the course. I just think that the flood of messages combined with the volume and variety of responses, with no real way to organize them, created a distraction. I would like to thank those who organized the on-line chemistry course, and all of the students and professionals whose papers were the topics of discussion, for an interesting experiment in education.
5. I thought the course went well. It was interesting to read material from experts and my peers. It was an interesting idea.
15. This on-line course would not have been successful without the classroom guidance, background presentations, discussions and focus.
16. The student papers were not as professionally written, as expected, as the expert papers. I may have higher expectations than most, but I was disappointed in the English composition-type problems that I noticed in the papers. Did their instructor proofread their paper? I would have been embarassed to post some of those! (I am picky!!)
23. Thank you for keeping us students up to date on what was going on on in the course. Also, my thanks for providing this course in the first place. It was an opportunity for much learning.
27. I hope this course is continued in the future. Despite a need for some improvements, I feel this type of educational medium will be even more widely used. I'm glad to have been a part of this in the beginning.
29. This was a very good experience and well worth all of the time that it took!
34. Was a worthwhile class hope it is offered again
36. Perhaps the questions could have been filtered.
38. I hope that similar courses will continue to be offered. This has been a unique experience, and I appreciate all of the work of the coursemasters and faculty members in putting it together. Thanks!

l. TIME SPENT

Average time/week is 5.3 hrs., S.D. = 0.43, n=34 (min. = 1 hr, max. = 12 hr)
Max. time/week is 11.8 hrs., S.D. = 1.8, n = 43 (min = 1 hr, max = 75 hr)
Min. time/week is 2.9 hrs., S.D. = 0.31, n = 42 (min = 0 hr, max = 9 hr)

% Time spent in class is 28.0 %,S.D. = 4.0, n=35 (min = 0 %, max = 80 %)
% Time spent reading and writing by self is 32.4 %, S.D. = 3.6, n = 33 (min = 10 %, max = 90 %)
% Time spent at the computer is 53 %, S.D.= 4.0, n = 33 (min = 20 %, max = 100 %) working collaboratively is 20.4 %, S.D. = 3.9, n = 31 (min = 0 %, max = 80 %)

Comments:

17. Maximum time spent when writing the paper and then when answering the questions about our paper.
19. The week I was finishing the paper, I was averaging 15 hour days.
25. The percentages varied when we wrote the student paper and first got on the Listserv.
34. Both working together, on-line, and by self was beneficial.
38. This is hard to answer because the amount of time varied from week to week, especially when we were writing our papers.
39. It was very helpful to be able to work in a group.

m. PERCENTAGES OF PAPERS AND DISCUSSION READ

Average 98 % of papers read, S.D. = 0.85, n = 42
36 of 42 respondents read 100 % of papers

Average 88 % of questions and discussion read, S.D = 2.3, n = 42
18 of 42 respondents read 100 % of questions and discussion

Comments:

21. Read 60 of on-line questions and discussion. The rest I skimmed through because of lack of time.
23. Many of the questions and comments got no more than a glance-over to see if they were worth further reading.
33. Some questions were good, while some were well elementary level.
44. The amount of on-line questions and discussion read dropped off at the end of the class due to my other class loads.

40 responses -
83 % Indicated amount of work required about right
17 % Indicated amount of work required excessive

Comments:

2. The in-class presentations were extremely helpful in understanding the paper discussed on-line.
3. Too little - As far as my university was concerned. I have spoken to the office here and expressed my exasperation with the total lack of instructor involvement in the class. Excessive - As far as the list-server was concerned. I think that the organizers need to consider the number of students involved as being a class with no restraints on who speaks or when. Either limiting the number of students or colleges involved, or using a different forum for the discussion would alleviate this problem.
17. Required more work than many of my other classes. This was by no means unmanageable, but you had to devote the time needed to keep pace with the others.
27. I believe this course should be expanded to a two credit course if possible. Ideally, the amount of work required for this course would be worth more than one hour credit.
29. The amount of work required for this course was excessive at times, but well worth it.
34. About right for a three credit course. Excessive for the one credit course I took it for, but it was interesting. I believe the course to be very worthwhile and hope it is offered again.

Programming Methods for the World-Wide Web

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Introduction

This article provides a basic overview of several common programming methods that are used to create interactive material for the World Wide Web (WWW).[1] Interactive Web pages can be textual, calculational, or graphical; and can serve as on-line versions of tutorials, homework problems, take-home exams, and other educational tools. The largest distinction between the different interactive methods is that some are client-side, in which all processing in done on the client computer, and others are server-side, in which all processing is done on the WWW server. Client-side methods include client-side image maps, JavaScript,[2] and Java. The question-and-answer information for client-side image maps and JavaScripts is contained in the HTML file, and users have access to the information by looking at the HTML source code. Server-side methods include server-side image maps, and scripts or programs called through the Common Gateway Interface (CGI). Server-side methods are most appropriate for delivering interactive exercises that access existing databases of information, or require tracking or grading capabilities. Client-side methods are most appropriate for practice exercises. Client-side methods have a major advantage in delivery speed over server-side methods in that they do not make a new connection and transfer data over the internet for the data processing step. This consideration can be very important for interactive material that requires many repetitive actions. Combinations of client-side and server-side methods are possible. For example, a client-side JavaScript can check the format of data entry before it is submitted to a server-side program for evaluation.

Hyperlinks

Multiple-choice exercises can be produced without any programming by simply using hyperlinks for each answer choice. When a choice is selected, the link retrieves a new HTML page that can indicate if the choice was correct or incorrect, and can also provide an explanation or a return link to try the exercise again. An extension of this simple hyperlink method is to create a graphical multiple-choice exercise using a clickable image map. Although this approach is simple, it can create a large number of files, requiring careful file management. The major limitation of using only hyperlinks is the inability to create interactive materials that require relational or calculational evaluation of a user's input. Such exercises require a programming method that can be interfaced to the Web.

Image Maps

Clickable image maps are in-line images that contain active areas, and provide a very simple means of creating interactive graphical components on a Web page. Clicking on an active area calls a specified URL, which can be a hyperlink to a different part of the Web page or to a new HTML file, or a call to a JavaScript function. There are two types of image maps: client-side and server-side, which differ in the placement of the information specifying the active areas. The client-side map information is contained in the same HTML file as the Web page that is being displayed, and the server-side map information is in a map file on the WWW server. Support for client-side image maps was implemented in Netscape Navigator 2.0 and compatible browsers. Client-side maps operate faster than server-side maps because they do not have to reconnect to the WWW server for each click on the image map. Client-side maps are also easier to develop because the files can be tested and edited on a local disk before transferring to a WWW server. Server-side maps have the advantage that the map information is not available to the user, so they can be used as interactive graphical exercises in on-line testing material. Clickable image maps can be created manually by typing in the coordinates of the active areas, but are easily created using one of the free or inexpensive image map programs that are available on the Web, such as MapThis or Mapedit.

- Imagemap Authoring Guide and Tutorial Sites, http://www.cris.com/~automata/tutorial.shtml.
- Imagemap Help Page — Instruction, http://www.hway.net/ihip/.
- MapThis Home Page, http://galadriel.ecaetc.ohio-state.edu/tc/mt/ (Win32 version only).
- Mapedit, http://www.boutell.com/mapedit/ (Windows and UNIX versions only).

JavaScript

JavaScript is an object-based scripting language that is supported by Netscape Navigator 2.0 and equivalent browsers.[3,4] Internet Explorer supports VBScript and JavaScript, although the degree of language compliance between Internet Explorer and Netscape Navigator is not 100%. Netscape Navigator 2.0x does not print a Web page generated by JavaScript commands, but Netscape 3.0 and compatible browsers will print script-generated pages. JavaScript is like other scripting languages in that it is fairly easy to use, and allows Web authors to write programs without a full-featured compiled language. The JavaScript code is contained in the HTML document, usually in the header section between <SCRIPT>...</SCRIPT> tags. The JavaScript is interpreted by the user's browser when a new HTML file is loaded, and any JavaScript statements that write to the page are executed before the HTML code in the body of the document is interpreted and displayed. JavaScripts can recognize and respond to a number of user events such as mouse clicks, form input, and page navigation. Form elements such as radio buttons and text boxes allow users to enter data, such as selecting choices or typing text, that can be evaluated by a JavaScript function, which then returns a response. (The form elements are the same as used to submit information to a WWW server for a CGI program to evaluate.) The disadvantage of using JavaScript alone is that no results from the user's actions can be saved to the server.

- JavaScript Authoring Guide, Netscape Communications Corp., http://www.netscape.com/eng/mozilla/Gold/handbook/javascript/index.html.
- JavaScript Index, Andrew Wooldridge, http://www.c2.org/~andreww/javascript/.
- The Complete Idiot's Guide to JavaScript, Aaron Weiss & Scott J. Walter, http://www.winternet.com/~sjwalter/javascript/index.html.
- Interactive Exercises for On-Line Education, http://www.chem.vt.edu/chem-ed/CHP/scripts/ (JavaScript and Perl examples).

Common Gateway Interface

The Common Gateway Interface (CGI) is a standard protocol that allows information to be passed between a browser program running on a client computer and an application program running on a WWW server. When a browser requests a *.cgi file, the server executes the script or program that is contained in that file. The CGI interface also passes any data that was submitted from the client to the program. The program evaluates the user input and returns a response. CGI can interface to any language that can be executed on a WWW server, such as C/C++, Fortran, TCL (Tool Command Language), PERL (commonly called Perl, although it is an acronym for Practical Extraction and Report Language), VisualBasic, HyperCard, and AppleScript. Non-compiled languages, such as PERL, are usually preferred due to their ease of modification, maintenance, and debugging (PERL is also free).0 CGI programs are executed on the WWW server using the resources of the server computer. Processor-intensive applications or the ability to serve many clients simultaneously can create a heavy load for a WWW server, requiring a powerful computer. The advantage of the CGI method is the ability to use sophisticated programming languages, and to have access to the server's hard disk to use existing databases or log user responses.

- The Common Gateway Interface, http://hoohoo.ncsa.uiuc.edu/cgi/.
- The Perl Language Home Page, http://perl.com/perl/index.html.

Java

Java was developed by Sun Microsystems, Inc. to create a simple object-oriented and platform-independent programming language to distribute application programs over the Web.[6] Java programs are called applets, and are included in HTML code. To create a Java applet, you write a Java program and compile it into a file of Java bytecodes, and include a reference to the applet using <APPLET>...</APPLET> tags in an HTML file. When a Java-enabled browser encounters the applet tags, the browser downloads the specified Java applet, interprets the Java object code, and runs it in a window on the browser screen. Applets are stand-alone programs that can accomplish a broad range of functions such as animation, calculations, graphing, etc., and could find wide utility in the creation of interactive learning material. However, Java is a highly syntax-dependent language, requiring some programming skill by the applet author, and the language is still at an early stage of development.[7] Microsoft is developing asimilar technology called ActiveX. Currently Internet Explorer 3.0 supports Java and ActiveX but Netscape Navigator 3.0 only supports Java.

- Java - Programming for the Internet, http://java.sun.com/.
- All About Java(tm), http://java.sun.com/aboutJava/index.html.
- Java(tm)/HotJava(tm) Frequently Asked Questions — Index, http://java.sun.com/faqIndex.html.
- VBScript and ActiveX FAQ, http://www.rollins-assoc.com/vbsfaq.html.

Visualization Methods

There are several methods for viewing and manipulating 3-D structures on the Web. Simple 2-D and 3-D visualization can be created with drawing programs and converted to simple or animated images. The following methods include some level of interactivity, in that the user can manipulate the 3-D object, or use the visualized object in an interactive exercise (e.g. hyperlinks in VRML or QTVR). Various representations of molecules; ball-and-stick, space-filling, etc.; in Brookhaven protein data bank (*.pdb) and other file formats can be displayed and manipulated with the Rasmol program. RasMol can also be set up as a helper application for a browser. Alternatively, an evaluation copy of the Chime Plugin for Netscape Navigator displays *.pdb and *.xyz files, and provides most of the functionality of the stand-alone RasMol program. An enhanced version of the RasMol program allows viewing of multiple molecules in the program window, bond rotation, and other features.

- RasMol home page, http://www.umass.edu/microbio/rasmol (Win, Mac, and UNIX versions).
- UCB ENHANCED RASMOL, http://hydrogen.cchem.berkeley.edu:8080/Rasmol/
- MDL Home Page (Chemscape Chime plug-in), http://www.mdli.com/

Virtual Reality Modeling Language (VRML) allows visualization and manipulation of 3-D objects in a window on a Web page. The user can change the position from which the object is viewed, including zooming in and out. VRML objects can include hyperlinks making it possible to use them as interactive 3-D exercises. Apple has developed similar panning and linking capability for QuickTime movies called QuickTime VR. VRML files have a *.wrl extension and QuickTime VR files have the same *.mov extension as regular QuickTime movies. VRML appears to be used mostly for 3D renderings of objects, and QuickTime VR for panoramic scenes created from video.

- VRML Architecture Group, http://vag.vrml.org/.
- Welcome to vrml.sgi.com, http://vrml.sgi.com/.
- Apple QuickTime VR Home, http://qtvr.quicktime.apple.com/.

Summary

The following table summarizes the methods discussed above and appropriate uses. Java and JavaScript are complementary tools. Java provides sophisticated programs that run in a separate window on the browser screen, and JavaScript provides a simple language that interfaces with Web page elements such as forms, etc. For security reasons, neither Java nor JavaScript can write to a user's hard disk. The CGI interface allows utilization of sophisticated programming languages and access to the server hard disk.

Programming Method	Typical Use
client-side image maps	navigation, graphical practice exercises
server-side image maps	navigation, graphical exercises that logs user answers
CGI	multiple-choice or calculational exercises that access databases or log user answers
JavaScript	multiple-choice or calculational practice exercises, easy to interface form elements and clickable image maps on a Web page
Java	stand-alone presentations or tutorials

This article has attempted to present an overview of Web programming methods. There are a number of other software tools for visualizing and manipulating objects and data that were not discussed in this article. A couple of noticable ones for education are the Shockwave plug-in that allows Macromedia Director, Authorware, and Freehand files to be viewed from a browser window, and Mathcad 6.0 or Mathbrowser for viewing mathcad worksheets.

- Macromedia: Shockwave Center, http://www.macromedia.com/shockwave/.
- Mathcad 6.0 Animation Gallery, http://www.mathsoft.com/60dir/animatio.htm.
- Mathbrowser Home Page, http://www.mathsoft.com/browser/index.html.

References

Note: all URLs listed in this article were verified 9/16/96.

[1] A good starting point to find programming and Web tools is: Yahoo! - Computers and Internet:Internet:World Wide Web, http://www.yahoo.com/Computers_and_Internet/Internet/World_Wide_Web/.

[2] Not to be confused with a server-side version of JavaScript, which is under development.

[3] Mark. C. Reynolds and Andrew Wooldridge, Special Edition Using JavaScript (Que, Indianapolis, IN, 1996); ISBN: 0-7897-0789-6.

[4] Aaron Weiss and Scott J. Walter, The Complete Idiotís Guide to JavaScript (Que, Indianapolis, IN, 1996); ISBN: 0-7897-0798-5.

[5] Till, D. Teach Yourself PERL in 21 Days; Sams Publishing: Indianapolis, IN, 1995.

[6] There are lots of books on Java (and the other topics in this article). O'Reilly sells several Java books at several levels of expertise; see: Java, http://www.ora.com/catalog/java.html.

[7] JavaScript is also at an early stage of development, but uses less rigorous variable typing and is therefore more forgiving for imperfect program code.

"Some Reflections On the Intercollegiate On-Line Course: Industrial and Environmental Chemistry"

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In this article I would like to take some time to reflect on the On-Line Chemistry Course which was taught last Spring. I am not going to dwell too much on the mechanical details of the course, as Don Rosenthal did an admirable job of that in his article in the Spring 1996 issue (pp. 16-20). I will express some of my observations about the course.

The organizing committee began its work in January of 1995, a full year before the course began. I would like to thank the committee (George Long, Don Rosenthal, Maria Pacheco, Reed Howald, and Carl Snyder) because I could not have organized this course without them. During this year a considerable amount of work took place. I wasn't sure at the time we could complete the preparations for the course, but we did. In the end there were 20 schools and 96 students which turned out to be about the right number. My thanks again to all those instructors and the authors whose commitment made this course a success.

After all of the thousands of pages of email and the countless hours of studying, guiding and reviewing, what

have we learned?
First of all I think we found that this approach to learning definitely has its place. The comments were generally good whether they were from instructors, students, or the authors. The students became more independent and learned how to grapple with ideas where the answers were not as clear as one would like.

The course topic is critical. An on-line course is not an easy way to get purely factual type information across. The traditional educational settings seem to handle this type of info reasonably well. The subject studied needs to have some element of controversy in it. This allows for a two way discussion between the students and the author. It allows for dialogue between a student and the author to examine controversial ideas on a deeper basis. Much factual chemistry is still taught, but it is shared within the framework of the broader discussion.

Can the traditional subject be handled via this format? Yes, but you need to be able to expend a considerable amount of effort to draw the students out as Theresa Zielinski did in our trial run of the course in the Fall of 1995. The biggest challenge, no matter what the subject, is to engage the students in dialogue by thinking through the issues, the subject, and the concepts together. In the process they learn. It should not be a case of the student asking a question and then sitting passively while receiving the answer from the expert.

There were some passive learners in the group and for them I am not sure how much of an advantage this course would be over a regular course other than hearing from three experts in their fields. The greatest learning experience probably came to those who wrote and defended the two student papers.

Part of the design of the course was to have groups of 3-7 students write papers on subjects related to industrial and environmental chemistry. Most professors either required or encouraged their students to participate. A committee then selected two of these papers for discussion by the entire on-line course.

The students in the two groups which had to defend papers learned a great deal very quickly. With roughly ninety students firing questions, accurate and rapid answers are called for. Although it was not practical, it would have been nice if every student had been involved in defending a paper. Explaining and defending ideas to others is one of the best ways to learn.
One practical problem which we had with the course was the early deadline for submission of the papers. The on-line portion of the course started on February 5 and the deadline for submission was February 26. Although some schools started classes well before February 5, at least one school didn't start until February 6. This gave very little time for the submission of a major paper. Given that we needed to be ready to discuss paper 4 by March 18, it seems difficult to imagine that a much later deadline would have been reasonable. In spite of the short time frame ten paper were submitted by the deadline. These were all solid papers and some were excellent presentations. These papers can still be obtained from the course web-site at
<http://dirac.py.iup.edu/college/chemistry/chem-course/webpage.html>.

A problem for the students and many of the faculty members was the large volume of email. This seems to me to be an unavoidable side effect of the course. There needs to be a certain level of email activity to generate the discussion level needed in the course. By luck perhaps, we managed to reach about the right level. However, students are not used to this level of email activity. Instructors need to teach students how to sift through the large volume of email.

There are some clear advantages to this approach to chemistry education. First, it allows expert authors to be made available to a small class and/or small school. Recruiting Dr. Trehy, Mr. Seelig, and Dr. Armor was possible because of the combined size of the operation, but would not have been possible for most of the individual classes.

The course provided the students with an opportunity to interact with the authors as opposed to just reading their material which is the case with text books. This was an opportunity not often granted to students. In addition the students were given a unique exposure to a large number of their peers. These experiences gave the students a broad perspective which they could not have had otherwise.

If you are interested in being involved in a course like this in the future, please contact Don Rosenthal at <rosen@clvm.clarkson.edu>. If you want to learn more about the spring semester 1996 course visit the website given above. There appears to be interest in another course like this one. The success of the course was a tribute to team work. A course such as this cannot succeed without the generous cooperation of many people. I wish to thank all those who helped to make the 1996 course a success.

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