

## New Initiatives in Chemical Education

An On-Line Computer Conference, Summer 1996

### Paper 7

# Networked Instructional Chemistry

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### Abstract

Computer software is used to replace some traditional laboratory experiments, collect and analyze on-line experimental data, enhance lectures and discussion sections with multimedia presentations, administer on-line quizzes, function as a prelab for beginning non-major organic lab, provide electronic homework for organic chemistry students, and give graduate students access to real NMR data for analysis. We have integrated computers into all components of chemistry courses. The software which performs these tasks has been developed by various individuals and organizations. Integration of a diverse collection of software into major components of courses is one of the most important aspects of using computers to teach chemistry. Integration is possible because of a computer network which makes all the software available to everyone taking chemistry, and because of management software which allows instructors to easily assign lessons by clicking on a lessons title presented as a list of lessons. This helps students and instructors view computers as a natural part of the course. A networked system with software management allows computers to be used for the things they do well, such as tracking homework completion and grading quizzes and allows instructors more time to interact with students.

# Students' Instructional Computing Environment

To have an impact on learning, it is necessary to have instructional software which is complete enough that it represents a major part of the course. However, the availability of instructional software is not enough to make the transition from traditional class work to new ways of learning easy and effective. It must also be easy for students to do their lessons and receive credit for their work. While the number of students who arrive on campus with no computer experience is decreasing, there are still students who are anxious about using computers to learn chemistry. We must make it as easy as possible for them to focus on the content of the lessons, and not on learning how to load computer programs. Other courses at the college level are designed to do that.

All students, freshmen, sophomores and graduate students begin with the same initial menu for selecting activities. Students who learn to sign on their first semester use the same signon procedure for all subsequent chemistry courses that use lessons provided by this technology center. As shown in [Figure 1](#), students can signon with their name and a unique identifier. No written instructions are provided or needed. A menu combined with instructions on the screen saves around 3000 sheets of printed paper instructions, and precludes continual verbal repetition of instructions. The menu program is flexible enough to allow new kinds of lessons to be added and old ones removed when needed.

A record keeping system must be available so that students can see that their scores have been recorded and they have received credit for their work. Most students are accustomed to receiving a piece of paper that they can keep on which the score is recorded. For students to be comfortable with on line grading of quizzes and homework there must be similar feedback available. Students need to verify that the computer has indeed given them the score they deserve. [Figure 2](#) shows a screen from the online gradebook that accompanies each chemistry course so that students can see all their scores in the course, and how their scores compare with those of other students.

In addition to activities that require students to signon with a name and password, several activities require no identification. Students can [Browse lessons](#), that is, use them while not receiving credit, which many do as review for exams. Students can use a set of programs entitled [Chemists' Toolbox](#), or they can access chemistry coursework on the [Internet](#) using the Netscape browser.

# Instructor's Instructional Computing Environment

A special instructional computing management system, Figure 8, has been developed which allows instructors to setup, Figure 9, and monitor the on-line components of the course. The class roster is imported from the University computerized registration system. Once the roster is in place, students can sign on with their names, course name, and passwords they select. This gives them access to the lessons assigned by the instructor.

Special tools for instructors have been developed to facilitate the use of instructional technology. For example, instructors select the lessons for a course from a catalog of lessons. The management system automatically records the lessons completed by individual students and the time spent working them.

Information about lessons completed is combined with exam scores, quiz scores, lab reports, and homework in the integrated on-line gradebook. Tools which make it easy to view, plot, and scale grades and assign course grades are provided for the instructor, Figure 10. Students have access to their scores only, and to overall course information such as bar graphs of exam or quiz scores.

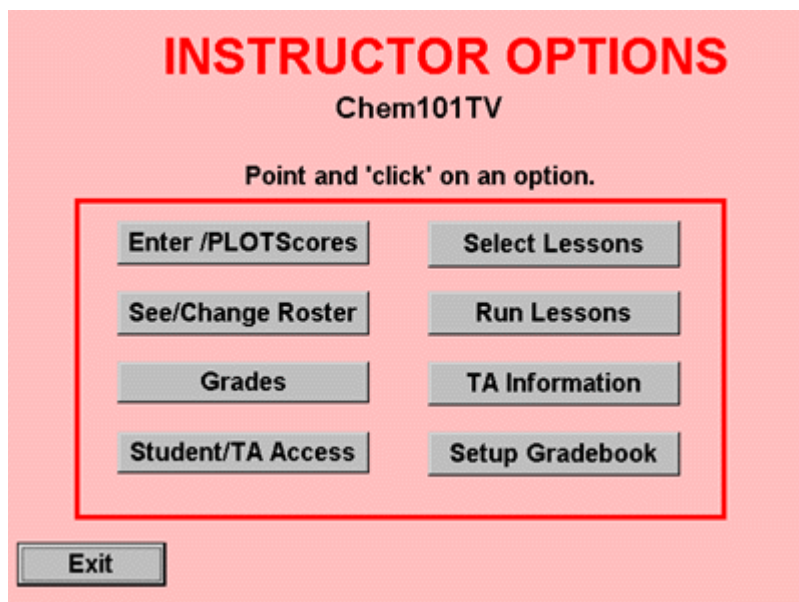


Figure 8

## INSTRUCTOR SETUP

Chem101TV

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Number of Exams	<input type="text" value="3"/>	<input checked="" type="checkbox"/> Final Exam?
Number of Labs	<input type="text" value="6"/>	<input type="checkbox"/> Lab Evaluation?
Number of Quizzes	<input type="text" value="12"/>	<input type="checkbox"/> Quiz Evaluation?
Number of Homework Sets	<input type="text" value="0"/>	<input checked="" type="checkbox"/> Computer Lessons?
<input type="button" value="Set Maximum Values"/>		<input checked="" type="checkbox"/> Scaled Scores?
<input type="button" value="STUDENT OPTIONS"/>		<input type="button" value="Scale Options"/>
<input type="button" value="EXIT"/>		

Figure 9

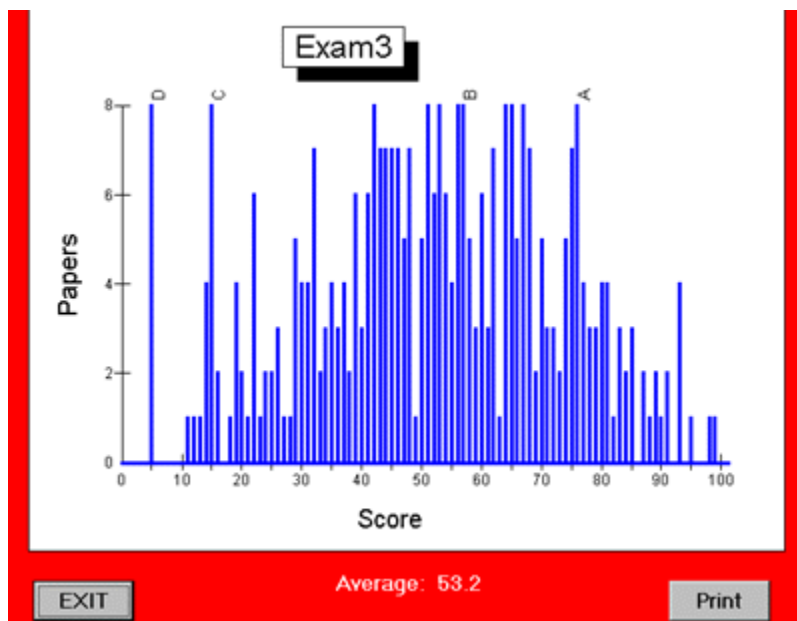


Figure 10

# The Physical Environment

## Chemistry Learning Center

The design of the room where most students access the computers is an important component in the creation of an effective learning environment. We have found that it is desirable to include study tables, books, and to assign teaching assistants to be there to answer any course-related questions. Instead of creating a dark computer room, we selected a location with windows and glare protected lights so the room is a bright and attractive study area. The room is supervised by a full time professional who is qualified to deal with both the computer technology and tutoring of individual students in chemistry. During a typical week in the fall semester, 3,000 to 5,000 students per week use the Learning Center for accessing lessons or consulting with teaching assistants.



Students use tables in the learning center to study and consult with teaching assistants.



The chemistry learning center has about 100 computers which are a mixture of 66 MHz 486 and 75 MHz Pentiums.



Students prefer to use the computers which are located in individual work spaces.

# Networking for Instructional Computing

Because our students use computer lessons as a required part of their courses it is essential to have a way to track individual student use. This is done by having all of the machines which the students use networked to a server which stores a common data base of names, courses, and lessons. Because of the large amount of data required to support full motion video the network has been configured for high effective bandwidth to individual stations.

Some important factors in the design of a network which supports multimedia based instructional computing are the [networking hardware](#), the [server and network operating system](#).

By choosing networking components carefully we have built a local area network for chemistry that is capable of delivering lessons with full motion video to over 100 computers. Even highly compressed video files are quite large and their delivery from the server to the student's computer requires a large amount of bandwidth. It would have been easy to have made a mistake in the selection of network components so that delivery of video was so slow as to make its use on a large scale impractical. If possible, it is desirable for chemists responsible for implementing the use of computers to teach chemistry to understand the the basics of networking for instruction.

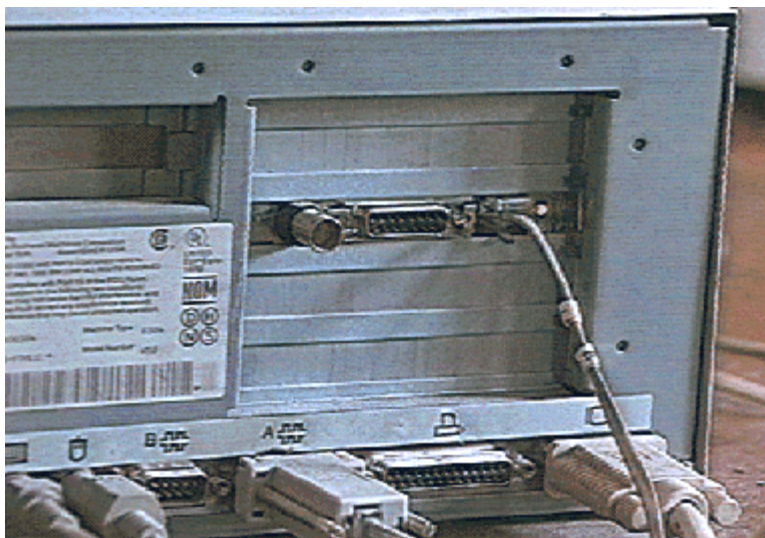


Figure 11, 10BASE T Ethernet connection on back of PC.

# Application Software

[Interactive, digital video lessons](#) replace up to half the traditional laboratory work for the first semester non-major general chemistry course. Students spend the alternate weeks doing wet laboratory experiments.

Computers are also used to [enhance wet laboratory experiments](#) by allowing students to collect data on-line, store it on the server, and review it later. Each group of students has a location on the server to store its data. No group can see or change another group's data. After leaving the lab, individual students can access and analyze their data from other computers on the network.

[Multimedia technology](#) is extended into the discussion classroom by equipping small classrooms with networked computers and large screen monitors. Small lecture-discussion sections with around thirty students per section are taught by teaching assistants who augment the traditional blackboard and chalk presentations with multimedia which includes both still and full motion video images of chemical reactions, demonstrations and example problems.

Weekly quizzes on the computer allow students to take the quiz at a time convenient to them. In addition, the quiz is graded immediately and students can see both their answers and the right answers within a time frame when such feedback is educationally effective. The Chemistry Quizzing System runs both on the [Internet](#), and on the local area network in the Chemistry Learning Center. The same quiz can be given on both the Internet and the LAN, or on either one.

Networked lessons are also used as electronic homework. In [organic chemistry](#) this takes the form of tutorial lessons with extensive practice problems.