Syllabus 2004

Chemistry Online Laboratory Preparation

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Introduction

The creation of an online Chemistry laboratory preparation Web site at East Carolina University was a collaborative project between faculty members in the Chemistry Department, the Harriot College of Arts and Sciences' Instructional Technology Consultant, Director and staff of the University Multimedia Center, and the Coordinator of the Center for Faculty Development.

East Carolina University is one of sixteen constituent campuses of The University of North Carolina. In 2003-2004 it enrolled 21,756 students and employed 1,463 faculty members. ECU offers baccalaureate, masters, specialist, and doctoral degrees in the liberal arts, sciences, and professional fields, including medicine.

The Chemistry Department offers B.A., B.S., and M.S. degrees and has 22 faculty members, seven tenured, eight tenure-track, and seven fixed term. Recently the department moved into ECU's new Science and Technology building with innovative technology-enhanced classrooms and laboratory facilities. Goals articulated in the department's mission statement include:

- development of innovative instructional techniques, and
- use of modern educational technology.

Statement of Problem

Enrollment in two foundation courses, General Chemistry I and II, totals around 1,000 students annually. For many years the department had used a 330-page printed manual that students studied prior to each weekly laboratory session. Its only visual elements were drawings of equipment, charts and graphs. Although a committee determined content of the laboratory experiments, multiple instructors conducted the pre-lab orientation sessions. Faculty members had several concerns with this system.

At an initial meeting of the team to discuss ways to incorporate teaching and technology, the focus quickly became concerns with the laboratory preparation for General Chemistry I and II. Faculty members expressed an interest in the creation of an online laboratory preparation manual. From the beginning, they were consistent about what they wanted.

They indicated a willingness to work with an interdisciplinary team to create a product that would address their basic concerns. A high priority for the department was to offer high-quality laboratory instructions consistent for all students. Faculty members also wanted to free up more time in the laboratory for students to experience “scientific discovery” and higher-level learning.

During the discussion period the University Multimedia Center was created, expanding the resources available for the online manual project. Interest in the project in the department was broad based, including both senior tenured and fixed term faculty members, many of whom teach sections of the general Chemistry courses. All indicated that they would like to go beyond a literal translation of the printed manual to create an effective online manual. In consultations with the ITC and the Multimedia Center staff, the faculty team explored best practices and guidelines for creating online manuals. They were particularly interested in incorporating multimedia components to enhance student learning.

Approach to Solving the Problem

As with any team project, there was a division of labor. Each project participant contributed his/her expertise and provided a backup check for other parts of the project.

Chemistry Department

Members of the Chemistry faculty were responsible for the substantive content of the online laboratory preparation manual. Individual faculty members took responsibility for each experiment. To assist the multimedia team, they developed a storyboard of each experiment and performed it for the multimedia team to film for visual reference. They viewed animations as they were being developed for clarity in over-all presentation and for instructional accuracy (e.g., timing of steps, clarity of instructions). They gave feedback on layout, presentation, and usability of online materials, and proofed all final materials. Instructors tested the online lab preparation in their courses and received suggestions for improvement from students.

University Multimedia Center

University Multimedia Center staff and students from the Communication Arts program in the ECU School of Art designed the layout, did all the multimedia work (animations, drawings), and prepared text materials (not a simple matter in Chemistry).

Instructional Technology Consultant

The Instructional Technology Consultant served as liaison between the department and the UMC, assisted with design and preparation of materials, evaluated animations and online components, watched over the project timeline, and proofed all materials.

Center for Faculty Development

The Coordinator of the Center for Faculty Development helped arrange the collaboration between the Chemistry Department and other team members, advised on formats and methods for transforming materials to a digital environment, provided support and encouragement throughout the process, and also proofed all materials.

Problems Encountered and How They Were Overcome

The primary problem was how to move from print to an online medium. All agreed that we could not use the narrative straight from the printed manual. Also, instructors identified topics to add to the online manual. Our solution was to storyboard each experiment and generate a written version prior to creating online materials. This enabled us to walk through the process of the experiment mentally and to make sure that the content and sequence were correct.

As with many technology projects, funding was a problem. Donation of time by Chemistry faculty members and others made the project possible. The project was part of the assigned duties of the Multimedia Center and the college's ITC, but certain activities and supplies required money. The university provided what it could in a series of bad budget years. The College ITC convinced their Dean to provide funds during the first year to hire a part-time art student for the project. Copyright issues required cooperation because even though rights to the manual and to new materials required no extra-university negotiations, our team members fell under three different categories of ownership under ECU's policies. All agreed to assign individual interests to the university and stipulate that any future profits would be used to maintain the project.

In its beginning the University Multimedia Center was staffed half of each day by multimedia technicians from ECU's Brody School of Medicine. An early crisis occurred when the School of Medicine withdrew its employees, leaving only the student assistant to staff the UMC on East Campus. At this point, only multimedia files for the first experiment had been developed. Academic Affairs decided to fund the UMC and assigned an interim director, who was also the College's former ITC and therefore was already familiar with and supportive of the project.

We also addressed several very practical problems. One was to make our product compatible with a variety of web browsers so students could use it in campus labs, in dorms, or off-campus. This required testing the online manual in a variety of computing environments. Another practical concern was how to represent chemical formulas. We tried many different ways of creating them – using equation writers in word processing programs or creating GIF files in Photoshop – before we decided to have an individual "draw" them, giving the most professional and consistent results. Even a seemingly - straightforward process such as proofreading had its perils. The sequence of proofreading was generally for the chemists to read first, and then the ITC and the Faculty Development

Coordinator. This led to two non-chemists who were faced with numerous "bubbles" and eventually with “titrating Noah.” Although this was an intriguing concept, we quickly unscrambled the letters to “titrating NaOH.”

Important Decisions and Choices made during the design process

The team made a series of decisions and choices during the design process that contributed to the overall design and functionality of the product. Some examples are:

- present material on the web so that students could access it easily.
- rethink the printed narrative to achieve a visual product.
- videotape experiments as a resource for animators in creating the animations.
- evaluate how realistic animations need to be, whether instructions are clear and timing correct.
- limit the use of animations to places where they were more effective than still photographs
- determine where interactivity was helpful to convey or reinforce content
- provide appropriate feedback where helpful to the student
- prevent interaction from obscuring the basic concept.
- maintain stylistic consistency, especially due to the frequent changes in art students working on animations; have a given student complete one experiment.
- choose the appropriate software, multimedia format, design elements and monitor size.
- adjust the level of interaction as students progressed through experiments and became more knowledgeable about Chemistry, requiring increasing interaction as the semester progresses, with gated advancement near the end.
- provide a way to sustain the project in the future.
- house the product in an appropriate place.

Online Multimedia Lab Preparation for Chemistry 1151 and 1161

The purpose of the online multimedia lab preparation Web site is to prepare students to perform experiments in two semesters of introductory Chemistry. The Web site combines textual information from the former printed lab manual with interactive animations, still photographs, or drawings illustrating the equipment, procedures, and techniques used for each experiment. Students are to complete the section for each experiment prior to attending lab. The Web site does not replace the lab experience, but prepares students for it.

The Lab Preparation homepage has links to areas of general information that apply to the entire course: Policies and Regulations, Safety, Fundamental Procedures, Equipment, Experiments, and Charts and Tables. There is also an Experiments link that accesses a page with links for 21 experiments (10 for Chemistry 1151, 11 for Chemistry 1161). The subsections for all 21 experiments have consistent links that follow a definite order—reach step is numbered consistently, reinforcing that order. This ensures that students learn

quickly where to locate each kind of information.

Step one is Safety, which is intended to be viewed first, followed, in order, by Objectives, Observations, Equipment, Techniques, Waste Disposal, Calculations, Grading Scale and Pre- and Post-lab Questions. The Procedures page is a textual explanation of the steps required to complete the experiment. The Techniques page contains interactive animations, still photographs or other visual resources that students navigate through to view a visual representation of procedures for the experiment. The format was chosen to mesh most effectively with the information to be presented. Interactive animations were used only where they provided the best description of the content. In some instances, such as the identification of an unknown, still photographs showing accurate color changes were preferable to drawn animations.

Experiments early in the semester require minimal interaction from the student. They are prompted to select the appropriate button when they are ready to move on or to repeat the step to watch it again. As the semester progresses, so does the level of interaction. They may be prompted to click and drag a piece of equipment or select an object to advance. In later experiments students must enter data to answer questions before the next step is presented. For example, in the experiment on molecular geometry, they must enter the number of valence electrons for two substances correctly before they move on to enter the central atom for those substances.

Conclusion

This project's success and active use by students are due to several factors that contribute to more effective teaching:

- Students find visual materials easier to comprehend. This is important for a discipline such as Chemistry where students have few to no experiential images to use.
- Students experience active learning, dovetailing nicely with the department's desire to focus on students learning science.
- There is consistent demonstration of procedures and techniques across sections.
- Information is accessible 24/7 and may be viewed multiple times. This fits students' varied schedules and is essential for the struggling student.
- The site design is user friendly, easy to navigate and visually elegant.
- There is more time for discovery during labs.
- Students are enthusiastic users. This was clear from the beginning when students who were testing the site shared the URL with their friends in traditional sections.

Completion of this fruitful collaborative effort has encouraged Chemistry faculty members to undertake additional new projects using multimedia to enhance the teaching of chemistry.