Project e^2-PALS: Electronically Enhanced, Peer-assisted, Asynchronous Learning of Science

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Abstract

Nicholls State University has developed a novel, "no-compromise" laboratory program in Chemistry and Physics to address the needs of distance learners. Regular laboratory courses are typically scheduled in one or two 3-hour blocks per week. Students in distance learning (evening) sections of these courses can work up to 12 hours per week to allow scheduling flexibility. Instructional technologies utilized include lecture videos accessible through CD or the Internet, online assessments, and online consultations (through Blackboard™). Implementation strategies to ensure effective delivery of instruction as well as logistical details are discussed.

Introduction

Nicholls State University was recently granted approval to offer Louisiana's first and only two-year Associate of Science degree program in Chemical Laboratory Technology. The program was conceived at the request of industrial representatives on the Chemistry Advisory Council (CAC) of Nicholls' Department of Physical Sciences. Companies represented on the CAC include Dow Chemicals, OxyChem, Motiva, BASF, Entergy, and Chevron. It is anticipated that a significant number of students enrolled in the program would be current employees from these companies and will likely need scheduling flexibility. This need is partially addressed by web-based courses that are already being offered by the Department. The problem of delivering the laboratory courses became immediately apparent.

A search of the Southern Regional Education Board's electronic campus revealed that existing implementations of the laboratory components of distance learning courses would not be acceptable for our program. These approaches include one or more of the following: (1) computer simulations, (2) experiments done at home using common household materials, and (3) completion of all laboratory experiments on-campus within a one to two week period. Simulations and use of household materials are fine for enhancing student understanding of content. However, we feel that it is very important for our students to develop practical skills with real laboratory equipment. Since we live in a litigious society, we are strongly against students doing experiments at home, unsupervised. We also felt that the third option would be too overwhelming for the students and would require coordination of schedules of enough students to justify the salary for the instructor. In this paper, we discuss a novel, "no-compromise" approach that, in hindsight, is probably the simplest and most logical provided that the instructional materials necessary for implementation are developed beforehand. The program design is based on the realization that, for the students we intend to serve, the problem is not so much "where" but "when" they can do the experiments.

Instructional Technologies

There are three key technology enhancements that, we believe, are essential for teaching in these modern times, especially for distance learning. Used individually, these enhancements may not have a significant impact on the effectiveness of a course. But a synergy results from utilizing them together. A common feature of these enhancements is that effort on the part of the instructor is expended up front (i.e., during the development phase). Implementation, in fact, makes the instructor's job easier. We were able to secure external funding from the Distance Education Initiative of the Louisiana Board of Regents to support the development phase and pilot implementation.

Lecture Videos

As maligned as it is as a paradigm for delivering instruction, the traditional lecture does facilitate learning. It is clearly preferable to just giving students a book to read and telling them to take the final exam when ready. A lecture on video compensates for the inability of distance learners to attend a live lecture. Asynchronous access to lecture videos (on CD or through the Internet) offers additional advantages.

- Audio-visual enhancements are conveniently incorporated. For example, it usually takes me 30 minutes setting up and another 30 minutes cleaning up every time I do an in-class demonstration of the experiments shown in the following movies. In a large lecture hall, the demonstration may not have as much impact on students sitting far from the demonstration table. With the demonstrations now digitally captured, all I need to do is project the movie to a big screen for everyone to see clearly or have the students watch the movie as an assignment.
    - Sample Movie 1. Demonstration that pure water is a poor electrical conductor.
    - Sample Movie 2. Demonstration that some compounds, such as baking soda, dissolved in water can produce mixtures that conduct electricity.
- The ability to pause, rewind, and fast-forward accommodates slow learners, gives students the opportunity to take accurate notes, and provides a resource for review.
- Tutors can get a quick review on topics of which they may have a weak grasp, allowing them to better help their tutees.
- Time constraints are not a problem. The lecture does not have to fit into a 1-hour or 1-1/2 hour period. Additional examples, with detailed explanations can be provided on the videos. If classes are cancelled due to a calamity (e.g. hurricane), instructors are sometimes forced to speed up lectures or skip some topics to make up for lost time.

Two important considerations made in developing our lecture videos were accessibility and viewer's attention span. If students were to access the movies through the Internet, the file sizes must be small enough for reasonably fast transmission through a broadband connection. We also have to provide a CD version for students without broadband connections. We used PowerPoint as the framework for organizing the lessons. Each movie file corresponds to just one PowerPoint slide (with voice-over and freehand annotation). The practical limitation in the amount of information that can be put on a slide forces the author to organize a lecture into concise bite-size segments. The average playing time for our movies is 4-5 minutes. Finally, the movies were packaged into a self-extracting, executable format for Windows computers. This eliminates potential problems of students not having the appropriate codec (compression-decompression) plug-in for their media player and/or not being able to install such codecs. All our movies were developed using Camtasia, a suite of programs that includes Recorder (a program that can capture everything that occurs on a computer screen to a movie file), Producer (an easy-to-use video/audio editor), and Effects (a program that allows addition of annotations to a movie). A free 30-day trial version of the program is available at www.techsmith.com.

Online Assessments

Telling students to watch a video is like telling them to read their textbook. Many students will not feel an immediate need to do so unless required to accomplish a graded task. Procrastination seems to be the main reason for student failure in distance learning courses. To address this problem, we require students to take online quizzes and set periodic deadlines throughout the semester. These allow students to focus on a manageable amount of information at a time. To quote an old adage, "Inch by inch, life's a cinch. Yard by yard, it's always hard." While distance education is meant to provide flexible scheduling, the reality is that students need to learn the required material in a span of one semester. We find setting deadlines 2 to 3 weeks apart to be a reasonable accommodation.

Another advantage of online quizzes is that they allow us to encourage mastery learning and keep students from being discouraged due to one bad score. To do this, we use "pools" in Blackboard™ (Bb). We listed all

learning objectives for each lesson and created a pool of questions for each learning objective. Online quizzes were then set up so that each item addresses one learning objective and Blackboard randomly selects a question from the corresponding pool. Therefore, the test is different every time it is generated. For example, if each item in a quiz were to be randomly derived from a pool of 10 questions, a 5-item quiz would have 100,000 different versions. This lets us allow students to retake a quiz (before the deadline) until they earn an acceptable score. Between retakes, the feedback from the online assessments provides opportunities to correct student misconceptions and encourages students to consult with the instructor or a tutor.

Online Consultations

A computer cannot completely replace a human being. It is not possible for any automated interactive assessment system to anticipate all possible questions that students may have. To serve the needs of students who have difficulty consulting face-to-face with the instructor, we utilize the Bb virtual classroom. It is essentially an online chat application, but it features an electronic whiteboard that students and teachers can use to communicate ideas through freehand drawings (molecular structures, diagrams, equations). Obviously, this is very important for Chemistry and Physics. A sample session, captured to a digital movie is posted at http://www.nicholls.edu/phsc/THEForum2004/BbSession.exe. Fast-forward toward the latter part of the session to see the use of the electronic whiteboard. In this movie, I used a SmartBoard™ in lieu of a mouse to facilitate writing on the electronic whiteboard. However, it is not necessary; a graphics tablet costing less than $100 (http://www.google.com/froogle?q=graphics+tablet) works just as well and I use one at home.

There are probably better ways of communicating online, but we feel that the Bb virtual classroom is our best choice at this time. In the past, I have used Microsoft NetMeeting, which allows voice and video transmissions as well. Unfortunately, transmission tends to be erratic when the other party is on a dial-up connection. Moreover, some students are not savvy enough to easily install the program. On the other hand, installation of the Bb virtual classroom is automatically done when a student clicks on the link to it from his/her browser. Voice communication can be helpful and can be easily added-on to a virtual classroom session using a regular telephone call. If the student's telephone line is tied up with the dial-up Internet connection, a cell phone would be an alternative way to talk to the instructor. The use of Bb virtual classroom also minimizes problems due to firewalls since it is a fairly standard Java plug-in for web browsers.

Laboratory Implementation

Our regular laboratory courses require students to attend one or two 3-hour sessions each week. Each session would typically involve a 15-30 minute pre-lab lecture and/or quiz, about 1-1/2 to 2 hours of actual "bench time" when students do the experiments, and the remaining time for data analysis (calculations, graphing) and consultations with the instructor. Students must have an experimental plan outlined in their lab notebook before being allowed to perform an experiment. Our evening laboratory sections are different in the following respects:

- Pre-lab lectures are available through the web or CD and students are expected to watch them before coming to the lab; see http://www.nicholls.edu/phsc/chemdl/measurements/module.htm. In addition to the experimental plan, they must pass a quiz (on Bb) before they are allowed to do the experiment.
- Students can work in the lab up to 12 hours per week. The labs are open from 6-9 pm each night, Monday through Thursday. Students can choose to come to the lab to be tutored or to do experiments. Students can also log in to Bb virtual classroom and join a conference (telephone) call to be tutored. A supervisor, which can be a faculty member or an adjunct instructor, serves as resource person, ensures that the students are safe, collects lab notebooks, and administers tests. Student workers (Chemistry majors) assist the supervisor and serve as tutors. At any given time, students enrolled in different courses can be doing different experiments.

Instructors of record (compensated on a per-student basis) grade student reports and practical tests, but need not be present at night as they will be available for consultation during regular office hours. All other typical tasks of a laboratory instructor are already taken care of. Lectures are available on CD. Kits containing materials and apparatus are ready for students to use when they show up (and can even be transported to a remote site such as a student's employer's laboratory or a high school – if an acceptable supervisor is available). Even analytic rubrics to facilitate grading of lab reports are ready to use. Students use the list of learning objectives as the holistic rubric; for an example, see http://www.nicholls.edu/phsc/THEForum2004/rubric.htm.

Fringe Benefits

Numerous fringe benefits are expected from this project. Being a small university, Nicholls can offer only a limited number of sections for some courses. This limitation often prevents some students from taking all their desired courses due to conflicting schedules or closed sections. This could happen to Biology majors who may need to take several Chemistry and Biology laboratory courses in one semester. Most laboratory sections are scheduled in the afternoon and conflicts are inevitable. If a section is full, it is difficult to justify opening another for, say, just 3 or 4 students. If a student fails or is unable to register in Physics 103 in the Fall, that student may have to wait until the next Fall because there are not enough students to justify opening a section of Physics 103 in the Spring (when most of the students who passed Physics 103 will be taking Physics 104). These students can all be accommodated in the asynchronous evening laboratory sections which we now offer year-round. In fact, the entire Physics 103 and 104 sequence can be completed in one semester. Meanwhile, on-campus students are also helping the distance learning program. The additional enrollment in the asynchronous laboratory sections helps to justify the cost of running the program. Finally, on-campus students are also benefiting since the lecture videos and online assessments are now being used in the regular laboratory sections as well. Not having to do a pre-lab lecture or quiz allows more time for student-teacher consultations after the experiments. Undergraduate Chemistry majors are given opportunities to earn money or internship credit by serving as tutors. More importantly, teaching their peers also helps them master the fundamentals of their major discipline.

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