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ABSTRACT

This paper describes how one university professor came to recognize that a computer-mediated learning environment can effectively facilitate student knowledge construction. During the 2001-02 academic year, he taught several online, undergraduate science courses at two different institutions. Delivery, which was entirely online, used e-mail, drop boxes, and Web-based lessons and resources. Threaded discussion was possible through a message board. The professor maintained online office hours via AOL Instant Messenger each week. He also developed online seminars via chat-room technology; an e-mail listserv to deliver professor notes and images; Web-posted PowerPoint presentations, video clips, and sound files; and online quizzes and exams. He discovered that student personalities and learning strengths and weaknesses could be perceived through their writing and drawings. Student feedback in all of the courses was positive, and students complimented his teaching. Based on his experiences with these courses, he redesigned one of his regular courses into a technology-enhanced science education course that includes both on-line elements and face-to-face components. (SM)

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Teaching Science On-Line: A Reflection on a Year's Experience

A Paper Presented at the 8th Annual Conference of the
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Abstract: Distributed education has come of age with multiple synchronous and asynchronous on-line technologies. The presenter, a veteran science educator, plunged into this new teaching environment in 2001-2002, teaching several wholly online undergraduate science content courses. From this experience, a hybrid "technology-enhanced" science education course was designed for 2003.

Introduction

The ERIC Digest entitled, "Effective Teaching in Distance Education" (1999) concludes with the statement, "The potential use of distance education within all disciplines is tremendous as this application to higher education evolves within our culture." (p. 2) I have come to see this as an understatement, but I felt differently only a couple years ago.

In terms of technology, I have always been "an early adopter." In working on my doctorate at the University of Virginia in the late 70s I had to get special permission from the administration to have my dissertation printed from a computer instead of typed. My Apple IIe was one of only a few personal computers in Ruffner Hall at that time. I was an early adopter in using some of the new electronic communication technologies in my teaching as well. In the early 90s I began with email listservs and later resources for my classes posted on my website (my first website was posted in 1997, still fairly early compared to my colleagues).

Even so, up until very recently, my firm opinion was that nothing could ever equal face-to-face teaching as a method of course delivery. I felt online education was just an easy way for students to get a diploma, akin to mail-order degrees. But experience has led me to change that view. Now I recognize that computer-mediated environments can effectively facilitate student knowledge construction. The access to information and multiple

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perspectives this medium provides make learning possible in new ways. Students cite the ability to get "information when you want/need it" as a strength of online learning (Jensen, 2000).

My jump into the virtual teaching-learning environment

During the 2001-2002 academic year, a year between leaving Virginia Tech and starting at the University of Tennessee, I taught several online undergraduate-level science courses (biology and environmental science) at two different institutions that deliver degree programs entirely online: Kaplan College, based in Iowa, and American Military University (AMU) based in Virginia. These kinds of programs I had viewed with contempt, but financial necessity led me to overcome my biases and objections and give online teaching a try.

Between summer of 2001 and summer of 2002 I taught five sections of introductory biology for AMU, with enrolments ranging from 8 to 22 students. I had a lot of latitude in designing this course, but delivery was entirely online and through the AMU interface. This interface did not have any synchronous instructional feature, only asynchronous technologies such as email, drop box, and web-based lessons and resources that students could download. Threaded discussion was possible as the interface had a message board, but I had not learned to use that when I first began. The three semester hour credit classes ran for 15 weeks as in a traditional model. Instruction was centered on a textbook (for this course, Starr, 2002). I selected chapters for students to read and created questions for them respond to in assignments. Lessons were designed to be delivered one per week and students had to deposit their weekly assignments as a WORD file in the online drop box via the AMU interface. These assignments frequently required drawings from nature, which proved to be challenging for many students (and their were many ways students accomplished this, from using a scanner to using digital cameras). The biology students also had to do a traditional term paper (though I modified this by the time I taught the course the third time, allowing several creative options, such as doing a multimedia or PowerPoint presentation or writing a children's non-fiction book on a biology topic).

In addition to the five AMU biology courses, in spring 2003 I also taught an undergraduate online course in environmental science for Kaplan College. My class enrolled 23 students. The Kaplan course also centered on a textbook , Cunningham, & Cunningham, 2002. However, Kaplan's web interface was very different from AMU's. Kaplan's courses were also more prescribed by the College as to structure. I had only a modicum of input into the course content and little control over the method of delivery. The Kaplan course ran ten

weeks – one of which was for a mid-term exam and "semester break" and the other for a final exam. So there were eight major lessons delivered. The Kaplan course used more online technologies than available at AMU. There was, for example, a weekly one-hour online "seminar" using the chat function. The chat interactions were archived after each session. Statistics were immediately available, such as how many times and for how long each student "spoke". I was able to re-read the transcript and to give students grades on their contribution.

The Kaplan course also had other teaching-learning methods: students submitted small-scale projects, completed "web field trips" and responded to discussion questions via an online message board. Students were required to interact with each other asynchronously by responding to each other's discussion board postings. Both the AMU and Kaplan courses included online exams and student assignments that involved web-based inquiries – such as having students locate and interpret data, maps, graphs or whole research studies found on particular web sites.

The Kaplan course was based upon a template used in all the courses they offered. Students were to be graded on the weekly online seminar, weekly quiz, and various weekly assignments, so that a student would accrue four or more grades per week. Students and administrators expected these grades would be posted immediately on an online Excel-like data sheet, and the preset weightings for assignments would be calculated with each entry so that students could get immediate summaries of their class performance. I imagine this level of "feedback" was appreciated by some of the students, but it was very demanding of the instructor. I have never done so much grading in 20 years teaching in higher education than I did for that online course. One saving feature was the 5th week break for catching up, but the two four-week stretches were very time consuming in terms of grading – and all of it online.

What's more, for the Kaplan course I had to maintain "online office hours" via AOL Instant Messenger each week. Students would enter a chat room here to ask questions or just to get more personally acquainted with the professor. I could have required office hour visits but I found several students "stopped in" regularly and shared their stories and got their questions answered.

The methods, or tools, of on-line teaching that I have now used include (but are not limited to), the following:

- the "drop box" for students to deliver their assignments
- the message board for student-teacher and student-student communication on a topic – the technology used in a "threaded discussion."
- on-line seminars via a "chat room" technology

- email listserv to deliver professor notes, images, etc.
- web-posted PowerPoint presentations, video clips, and/or sound files for students to access through their browser
- online office hours
- online quizzes and exams.

The most novel teaching method I experienced in this initial year of online teaching was the online seminar, or "chat session," which is a key feature in the Kaplan program. The Kaplan chat interface automatically gathered all sorts of data during the seminar – including attendance and how many times and for how long each student (and myself) "spoke." And this data was delivered to me after the session to be figured into my grade for each student for the sessions. Students who missed seminar for a valid reason were to have seminar make up assignments related to the seminar topic. Which was another grade that had to be kept track of by the instructor. The chat sessions with twenty-some participants were, to me, only somewhat worthwhile. I found it difficult to trace and respond to the multiple conversations that inevitably erupted with so many participants. I'm using chat with one of my graduate courses now at UT, with only four participants, and I find it works very well and student feedback has been positive.

What I learned that took me aback, in terms of my preconceptions, was that student personalities and learning strengths and weaknesses could indeed be perceived at a distance through their writing and the drawings and photos posted through the web. I also found students reporting that they learned a lot in these courses, and, to my surprise, they even complimented my teaching.

I found myself improving the course by developing better questions and assignments with each successive teaching. For example, in several assignments I asked students to describe local problems or issues that related to the course content being studied. I also decided that the students in the AMU biology course should experience something of the living world in their own local environment. So when I revised the syllabus for the next online course, I added this "self-guided field trip" assignment for Week 1:

> Visit a natural area near your present location, such as a nature preserve or a large park with a nature trail. Spend some time hiking and observing or "Seton Watching" – sitting at an observing post in a natural setting. Your observing session should be at least half an hour. Identify the place and the date and time span of your visit. Make a list of the living things you observed and the state of their being (for example, active, or dormant). Write down two or three things you wonder about as you observe.

> Optional: sketch an association of three or more organisms (plant, animal, fungus, etc. – can be a close up view or a view at a distance).

I found that several students did the optional sketches, which they scanned and sent as gif or jpg files, or imported them into WORD files with their list of living things. Here is another example of a weekly assignment intended to connect students to their local environments, this one in the botany unit of the AMU biology course:

> Locate a plant in flower or obtain a flower from a florist or garden center. Study the blossom of the flower. Identify your flower and describe the flower and its characteristics (shape, color, fragrance, etc.). Take your flower apart and notice the parts and how they are connected.

Unfortunately, I found several students who simply had no access to flowers, as they were taking this course from military outposts such as Bosnia. In fact, one of the amazing things about the AMU students was their far-flung locations. I had students in each class that were all over the world. In their circumstances, an online course such as the one I taught was the only educational option other than self-teaching through books (and they may have been harder to come by than internet access).

Here is an example of a similar assignment in the Kaplan environmental science course intended to connect students to their own locale:

> In this project you will examine up close a real parcel of nature somewhere within the area where you work or reside. Locate a natural area, preferably one with one or more marked trails that you have never visited or have not visited for at least ten (10) years. If such a place does not come immediately to your mind, you can find out about accessible natural areas in your area by contacting your local department of parks and recreation. Alternatively, seek information about nature preserves and parks in your area on the Internet. Look for this information on the websites of your state's park or forestry agencies or those of the local chamber of commerce or tourism bureau, or look for Nature Conservancy preserves on the Nature Conservancy website (http://nature.org -- has state links). Once you have decided the site for your field trip, plan your visit (some Nature Conservancy tracts require permission). Aids for "seeing" include a pair of binoculars, a magnifying lens, and a camera. Plan to take a sketchpad and pencil or a camera so that you can draw or photograph a scene from your field trip involving the relationship of three or more organisms (plants or plants and animals or plants and fungi). This might be a relationship between large organisms such as trees or small organisms observed through a magnifying lens. Your drawing or photograph

> can later be scanned and exported in gif or jpeg (jpg) format and then incorporated into the report you write about your field trip.

For this assignment I received image files created in a number of ways, and some students reported that they had had to learn to use a scanner or digital camera that they had borrowed to do the assignment.

Overall, student feedback in all the online courses was positive. Many reported, for example, that they had never been to the particular natural area they chose for their self-guided field trip, though it was accessible to where they live. One student sent me an email that stated, "I want to take this opportunity to thank you, again, for a wonderful class. I've thoroughly enjoyed the Kaplan experience and Environmental Sciences in particular. Lesson 6 (the self-guided field trip) will stand out in my memory for a long time." Others wrote, "I would have to say that this was an extremely fulfilling experience that I was fortunate enough to be able to get bits and pieces of it captured on our digital camera. This experience has given me hands-on proof that nothing is always, as it seems. You have to look at things with an open mind." and, "I really enjoyed myself on this field trip and would happily do it again, matter of fact I have started to walk here because its so peaceful." And another, "I would like to thank you for the opportunity to take this trip. My kids and I really enjoyed ourselves."

Another type of assignment that I found to be effective as a teaching method was the web-based inquiry. Some were more involved than others. Here is an example of a simple web-based assignment that was used in the AMU introductory biology course: "Do a web search on any of the themes or concepts in this week's ecology lesson – for example, "population growth," "pollution," "air quality," "status of the environment," etc. Write a paragraph about your most interesting findings. List the URLs." My experience was that students were able to learn a lot in their web inquiries. There were many postings that showed students searching beyond what I had required in the assignment. For example, here is part of a response from a Kaplan environmental science student:

> I felt this was one of the more difficult web field trips. The web sites were informational, but I thought they were too technical, so I also went to other websites to understand a little better. I couldn't get into anything in www.who.int/whosis - it kept telling me it was busy. However I did get most of my information from www.who.int/health-topics/idindex.htm.

Other students remarked about finding particular sites interesting or sparking curiosity, such as, "I had no idea about this and now I want to know more."

A Scholar's Perspective

Just a couple of weeks ago, at the Association of Teacher Educators meeting in Jacksonville, FL, I attended a featured presentation by Dr. Christopher Dede, the Timothy E. Wirth Professor in Learning Technologies at Harvard University. Dede (2000) describes the facilitation of distributed learning as "orchestrating educational activities among classrooms, workplaces, homes, and community settings" (p. 187). His hour-long session featured a high tech PowerPoint presentation with live internet site inserts. He shared his experiences and research on cutting edge teaching-learning technologies. Dr. Dede spoke of "distributed education across time, space, and media" (with the term "distributed education" preferred over "distance education"). He also spoke of these online teaching technologies as "representational containers." One of his PowerPoint slides presented the results of his research as:

"Beyond McLuhan:

- media shape their messages
- media shape their participants
- infrastructures shape civilization"

That is, "the integration of interactive media into learning experiences profoundly shapes students' educational experiences." Further, he emphasized that "face-to-face instruction" was but one of many teaching methods that we should be using to reach our students. Some other methods/tools that he mentioned were new to me, such as MUVEs (multiuser virtual environments that use digitized museum resources and in which the user or student creates an avatar, or virtual persona). Tapped In is a MUVE developed for the professional development of educators (http://www.tappedin.org). In teaching via this technology, Dede assigns students to small groups that meet in a virtual conference center inside Tapped In, which provides a virtual context and avatars used to explore digital artifacts. Another groupware tool I learned about is called Groove (http://www.groove.net). This is a team-based learning environment for small groups to work together on a shared document. They can brainstorm on a white board, examine websites, and talk in real time with each other, either through text or via microphones and headsets. Dede asks groups to create an artifact (such as a collaborative story or a design for a school) within their common virtual work-space. A similar technology is NetMeeting (http://www.microsoft.com/windows/netmeeting/).

Dede listed many such methods/technologies he uses in his own classes, and pointed out that at the end of his courses he always asks students to rate the methods in order of preference in terms of their impact on their own learning. He said that these polls over many

years have indicated that "face-to-face" rarely is selected the first choice by students (but usually is the second choice). He stated:

> Distributed learning is not traditional distance education, but instead involves educational experiences that combine the use of face-to-face teaching with synchronous and asynchronous mediated interaction. This instructional strategy distributes learning across a variety of geographic settings, across time, and across various interactive media. For example, in our MUVE, students alternate classroom discussions with simulated virtual experiences that can include remote participants. A variety of studies indicate that distributed learning adds important dimensions to face-to-face instruction, enabling some learners who might be silent in classroom settings to "find their voices."

Dede's website at Harvard provides lots of links to his research and information about some of these cutting age teaching-learning tools (see http://www.gse.harvard.edu/~dedech/502/). I left his presentation very excited about computer-mediated education, synchronous and asynchronous media, and all the new forums for the exchange of ideas across time and distance.

Taking Science Education Online at UT

Based on my experience with the AMU and Kaplan courses, I redesigned one of my regular classes at the University of Tennessee into a "technology-enhanced" science education course that includes both on-line elements and face-to-face components. The course, SciEd 565: Issues and Trends in Science Education" will debut this summer if it receives final approval from the Graduate Curriculum Committee. UT uses Blackboard as its interface for online class activities, which is different from both the AMU and Kaplan interfaces. This year I have integrated into my classes many of the technologies available on Blackboard, including the chat function, message board, posted documents and images, and email lists. What I believe now is that face-to-face instruction will always be of primary value, especially in terms of establishing student to student and teacher to student rapport, but I also have come to believe that tertiary courses can be greatly enhanced through the use of the many new instructional technologies now available.

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