AC 2007-1999: A HYBRID DISTANCE LEARNING MODEL USED IN A INTRODUCTORY CIVIL ENGINEERING COURSE FOR HIGH SCHOOL STUDENTS

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A Hybrid Distance Learning Model used in a Introductory Civil Engineering Course for High School Students

Introduction

The recruitment and retention of students in engineering is essential to meeting the needs of industry. Therefore, institutions have devoted significant resources to offering courses in a variety of formats. Online instruction has become widespread and is well documented[1,2,3]. Many of these studies suggest that students appreciate the "face-to-face" time with professors and also like the format of "anytime" online education. The paper presented here describes a hybrid distance education model used to teach an Introduction to Civil Engineering Design course at the University of Nevada, Las Vegas (UNLV) to high school students at Las Vegas Advanced Technology Academy (A-TECH) who had an interest in the engineering field. This approach was used to recruit high schools into civil engineering and as a means for efficiently offering sections of an introductory course in civil engineering.

UNLV Undergraduate Curriculum

UNLV has a total enrollment of approximately 28,000 students (undergraduate and graduate) and is primarily a commuter campus. The Howard R. Hughes College of Engineering provides education to approximately 1,300 undergraduate and 250 graduate students with about 60 full time faculty members. Within the College of Engineering, the Department of Civil and Environmental Engineering has 16 full time faculty members and offers degrees at the bachelors, masters, and doctoral levels. The civil and environmental engineering program is ABET accredited and requires students to earn a total of 132 credits leading to the degree of Bachelor of Science in Engineering with a major in Civil engineering.

K-12 Partner

The partnership between UNLV and A-TECH started in October of 2001 to foster the development of an early studies program for high school students interested in engineering. The A-TECH instructor's reason for initiating the contact was to expose students to real engineers and real engineering subjects in the high school classroom in hopes that students would elect to major in engineering when they matriculated at universities. The motivation for UNLV's Department of Civil and Environmental Engineering was a chance to improve UNLV's image, show students the available resources at UNLV, and to motivate local high school students to attend UNLV majoring in Civil, Electrical or Mechanical engineering.

The Introduction to Engineering Design (EGG 102) was selected because many engineering programs across the nation now require a general course that introduces the subject of engineering and requires a freshman design experience. An early studies credit in EGG 102 would most likely be a course that could transfer into other programs, both as general college-level credits and also as a course that would count towards the engineering requirements of many engineering degree programs.

Description of Introduction to Civil Engineering Design Course

As noted above, the course used in the partnership has changed and is now CEE 110: Introduction to Civil Engineering Design which is a required course taught to freshman Civil Engineering students. The prerequisites for the course are Precalculus and Freshman English Composition - all A-TECH students had (or were taking) Precalculus. The overall course objectives are to:

1. To identify the phases of the engineering design process.
2. To design an engineering project and construct a physical model of the project.
3. To prepare a technical report for a design project and make an effective oral presentation that summarizes the project.
4. To recognize the importance of working in a design team.
5. To recognize the importance of the NSPE Code of Ethics and the responsibility of Professional Engineers.

The textbook is Engineering by Design[4] that is based on the five phases of the engineering design process:

1. Needs Assessment
2. Problem Formulation
3. Abstraction and Synthesis
4. Analysis
5. Implementation

Description of Hybrid Course

The hybrid model consisted of distance education using video and posting of course material which was supplemented with face-to-face student sessions. This is different from traditional online courses in that a mix of web-based delivery with face-to-face sessions was used. The video portion of the course was produced and taped at an on-campus facility by the instructor and then posted on WebCT for video download at A-TECH where the high school teacher (Gauthier) facilitated the class. The biggest change from traditional face-to-face lecture format was the dividing up of the course material into modules that could be delivered via video. By doing this, it was found that on average a 30 minute lecture could be delivered in approximately 15 minutes in the studio. A listing of the video modules for the course is provided in Table 1.

Other material posted on WebCT for the students to obtain included in-class exercises, homework, and class notes, and other supplemental material. Students at A-TECH performed the in-class exercises at dedicated times during the video lecture (see Figure 1 for an example). The face-to-face follow up meeting (once a week) with the students discussed these exercises.

Table 1: Schedule of video lectures for CEE 110. Each video is approximately 15 minutes in length.

WEEK	LECTURE	SUBJECT
1 (1/23/2006)	1-1 1-2	Introduction to the Course Introduction to Civil Engineering
	2-1	Writing problem statements
2 (1/30/2006)	3-1 3-2	N-th Engineering Working in Teams
	4-1	Design Projects & Brainstorming
3 (2/6/2006)	5-1 5-2	Technical Reports Establishing Need and Types of Problems
	6-1	Statistics in Engineering
4 (2/13/2006)	7-1	VIDEO: "Building Big – Bridges"
	8-1 8-2	Introduction to Trusses Analyzing a Truss
5 (2/20/2006)	9-1	Trusses and Applying Method of Joints
	10-1	Build a Straw Bridge
6 (2/27/2006)	11-1	Formulating the Real Problem
	12-1	Duncker Diagrams
7 (3/6/2006)	13-1	Kepner-Tregoe analysis
	14-1	VIDEO: "Building Big – Dams"
8 (3/20/2006)	15-1	Design goals
	16-1	Design analysis and Decision Matrices
9 (3/27/2006)	17-1	Appropriate use of Graphs
	18-1 18-2	Models Scaling in Drawings and Models
10 (4/3/2006)	19-1	VIDEO: "Why the Towers Fell"
		First Prototype Bridge Testing
11 (4/10/2006)	20-1	Models / West Point Bridge Designer
		Models / West Point Bridge Designer (continued)
12 (4/17/2006)	21-1	Introduction to Computer Programming
	22-1	Flowcharts and IF Statements
13 (4/24/2006)	23-1	For/While Statements and Arrays
	24-1 24-2 24-3	Guide to Oral Presentations (1-5) Guide to Oral Presentations (6-10) Guide to Oral Presentations (Examples)
14 (5/1/2006)		Work on projects
		Work on projects
15 (5/8/2006)		Final Presentations / Testing
		Final Presentations / Testing

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Exercise #9

Names _____

Duncker Diagrams

Consider the current design problem of obtaining additional water for Southern Nevada. Our current allotment from the Colorado River (0.3 million-acre-ft) is being fully utilized and we now need to seek additional water resources.

The **Present State** is that the current water supply is fully utilized.

The **Desired State** is to have a safe and secure water supply that will allow Southern Nevada to develop over the next 25 years.

1. Organize into groups of three to four:

2. Create a Duncker Diagram (see the second page of this sheet) that addresses the water supply problem and identifies all possible solutions (20 minutes). Do some DRAFTs until your team gets the format sufficiently well worked out and then fill in the final diagram. Extra pages of the Duncker diagram will be available.

3. Several teams will be asked to present the results of your Duncker Diagram on the whiteboard (10 minutes).

Remember! There are many ways to solve the problem, including building new facilities and/or reducing the demand for water.

Please be creative

You don't necessarily need to be entirely practical at this stage.

Figure 1: Example in-class exercise that student performed during designated times in the video lecture.

Even though the course was delivered through distance education, a project-based approach exposed the students to the concepts and processes involved in engineering design. Approximately ½ of the course was hands-on activities (using physical and computer models) where the students are able to apply fundamental engineering concepts to real life activities. Examples of these activities include the forces on structures demonstrated through bridge construction, strength and fatigue of materials through failure analysis of common household items, and impulse-momentum through the construction of a balloon powered aircraft. All

activities were performed in teams of 3-4 students. The other half of the course was devoted to the steps in the engineering design process. Students demonstrated mastery of the material at the end of the semester by working on a design project which consisted of the construction of a newspaper bridge. Each student was assigned tasks and was held accountable for that portion of the design project. A description of the project is provided in Figure 2. Examples of the final models are Figure 3.

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Hoover Dam Bypass Newspaper Bridge Design Project
Ground rules and constraints

The increased traffic crossing Hoover Dam, and the increased security concerns at Hoover Dam have lead to the proposal of a bypass that will be located downstream of the Dam. The Hoover Dam Bypass project will create a new 3.5 mile corridor on the Nevada and Arizona sides of the Colorado River. The bridge crossing the Colorado River will be approximately 2000 ft long. **It is the objective of your design team to design and build a 1:500 scale model, out of newspaper, of the Hoover Dam Bypass bridge that meets the following guidelines**

Timeline

- **Phase 1: Problem Definition –** (Report Sections 1.0)
- **Phase 2: Identification of Alternatives –** (Report Sections 1.0, 2.0)
- **Phase 3: Selection of Design Alternatives –** (Report Sections 1.0, 2.0, 3.0)
- **Phase 4: Design Analysis for Preferred Alternative –** (Report Sections 1.0, 2.0, 3.0, 4.0) & 1st Prototype (1:1000 scale)
- **Phase 5: Presentation and Competition –**
- **Final Report Due**

Report Format

Title Page
Cover Letter
Table of Contents
List of Figures and Tables
Executive Summary

1.0 **Introduction and Problem Definition** (Formal problem statement, relevant background information, discuss examples and provide photos, etc..)

2.0 **Identification of Design Alternatives** (discuss the various alternatives that are available and feasible, what type of preliminary analysis do you have to perform)

3.0 **Selection of Alternatives** (discuss the methods you will use to select between the alternatives)

4.0 **Description/Design of Preferred** Alternative (discuss the final design alternative, any relevant calculations should be provided, detailed drawings of the site and the structure, cost estimate, other design considerations such as government regulations)

5.0 **Conclusions and Recommendations** (include your final recommendations, what additional work should be done, how long will the project take to build, post project monitoring, etc…)

6.0 **References**

7.0 **Appendices**

Figure 2: Description of final project for CEE 110.

Figure 3: Examples of final projects with and without loads applied to the bridges.

Assessment

The assessment of student learning was performed with an end of the semester survey that focused on the use of distance education as a form for delivering the class material (See Figure 4). Survey results indicated that the use of video lecture was effective and the students appreciated the professional nature of the videos. The videos conveyed the essential class material while still giving the students opportunities to be engaged during the lecture through in-class exercises. In addition, the students felt that the face to face meetings were effective for clarifying concepts from the lecture and obtaining feedback on in-class exercises, homework, and the project.

At this time, the data for this assessment was not available. This data may be presented as part of the oral presentation. To properly assess this type of course, it would be needed to compare the overall course performance of students taking the course through traditional lecture format to those students taking the course through the hybrid version of the course. At this time, only the hybrid version of the course is offered to the high school students. If the feedback from the first two classes is positive, a more rigorous assessment of student learning will be performed.

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ASSESSMENT ON THE USE OF DISTANCE EDUCATION

Please circle the appropriate response to the following questions. Please note that all responses are anonymous.

	Strongly Agree 1	Agree 2	No Opinion 3	Disagree 4	Strongly Disagree 5
1. The use of TAPED LECTURES was effective	1	2	3	4	5
2. The material posted on WebCT was easy to access	1	2	3	4	5
3. The material posted on WebCT was a good supplement to the taped lectures	1	2	3	4	5
4. I am confident that I met the course objectives	1	2	3	4	5
5. The face to face meetings were valuable for supplementing the material on WebCT and the taped lectures	1	2	3	4	5
6. My overall impression of the course was favorable	1	2	3	4	5
7. I plan on majoring in engineering in college	1	2	3	4	5
8. I plan on majoring in CIVIL engineering in college	1	2	3	4	5
OTHER COMMENTS ABOUT THE COURSE FORMAT					

Figure 4: End of semester assessment survey

Conclusions and Instructor Observations

The use of distance education coupled with face-to-face sessions in this course was useful in offering an introductory engineering course to high school. There are various observations that will help those that consider this type of activity:

1. The taping of lectures requires that the instructor have a well organized lecture that can be delivered using any media (e.g., PowerPoint, slides, physical demonstrations) that are broken up into well defined modules.
2. Even though the video lecture is condense (from about 30 to 15 minutes), the core material is able to be "covered." This does not ensure student learning, so other activities (e.g., exercises, homework, face-to-face sessions) are required to reinforce course material.
3. Working with high school students requires an understanding of the difference in maturity as compared to university students. In general, the A-TECH students needed more external motivation from the instructors to turn in their work. The high school instructor, Mr. Gauthier, provided regular reinforcement of the need to stay on task and turn in assignments in a timely manner. High school students are also more likely to lose focus and become diverted in to other topics that interested them.

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