

2006-251: TEACHING A PAPERLESS, ALL DIGITAL COURSE THAT UTILIZES THE EXPERIENTIAL LEARNING THEORY (ELT)

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Teaching a Paperless, All Digital Course that Utilizes the Experiential Learning Theory (ELT)

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Abstract

This paper describes a course, CE 526 - Design of Temporary Structures, taught in the School of Civil Engineering at Purdue University in the spring semester of 2004. This course features a digital version of Kolb's Experiential Learning Theory (ELT). ELT has been developed by several researchers and experimentally implemented in higher education for more than a decade. The course features the use of ELT in a paperless classroom. The paperless class was made possible through the use of a wireless network and pen-based tablet devices used by the instructor and the students. The course features all content (topics, references, quizzes, tests, homework) in digital form and a customized web site with features for this type of class. This paper will describe this course and lessons learned from using this approach. This approach provides improved productivity for delivering educational content in a university.

Introduction

This paper describes a course, "CE526 - Design of Temporary Structures", in Civil Engineering at Purdue University that adapts Kolb's Experiential Learning Theory (ELT) for learning content development and utilizes wireless technology in the classroom. To investigate how the theory can influence learning/teaching in engineering education, the authors explore the learning theory and apply to a course in civil engineering. In order to achieve a new paradigm of the computer-based learning in engineering education, the approach utilizes wireless technology along with Pen-based Tablet PC used by the instructor and the students in the classroom. This enables a new learning environment called "Paperless Classroom."

The ELT is a learning theory that describes learning as a four-step cycle based upon the orthogonal relationship of two continuums of cognitive growth and learning^{2,3}. Kolb describes experiential learning proceeds through four modes: Concrete Experience (CE), Abstract Conceptualization (AC), Reflective Observation (RO), and Active Experimentation (AE) based on how people obtain knowledge and develop². To date, the new direction of ELT is conceptualizing an idealized learning cycle where the learner "touches all the bases" of the four modes of learning in a recursive process⁴. The complete learning cycle requires all four steps (Figure 1); thus, a proficient learner is able to complete all steps in the cycle although one prefers certain modes of learning⁷.

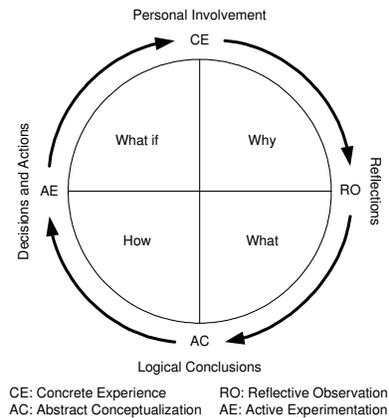


Figure 1. Idealized Learning Cycle Based on Wankat and Oreovicz⁷

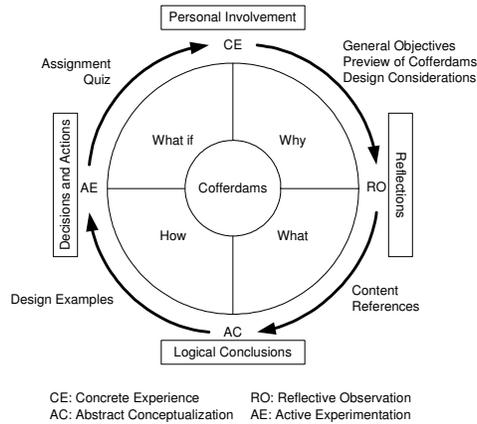
Design of Temporary Structures

Targeting graduate and senior undergraduate students, CE 526 discusses the design of temporary structures used in the construction industry. The course describes not only design issues of temporary structures such as formwork, tieback system, scaffolding, cofferdams, and others, but it also covers business aspects associated with the design and construction of temporary structures in the real world such as business practice, legal aspects, and design philosophy. The course features the use of Kolb's ELT in an online environment. All the course content has been developed by Dr. McCullouch and is available through the course Website. One of the goals of this course is to determine how technology can be used to deliver content and create an educational experience. The course provided an example of the use of ELT and 100% online delivery in engineering education.

In developing the course content, the authors utilized diverse multimedia resources that may provide efficiencies in learning that have already been verified by several researches^{1,6}, proving the impact of multimedia on student's learning and retention. Taking this into consideration, the authors paid more attention to appropriate use of multimedia resources when developing the course content. In addition, utilizing the wireless classroom environment, the course has on-line, in-class lectures and quizzes. With the use of wireless technology this course design method is expected to offer a new paradigm of the computer-based learning in engineering education.

Use of ELT in Course Content Development

The course content development utilizes Kolb's ELT (Figure 1). This paper discusses one of the topics in CE526, Cofferdams. Cofferdams describe design procedures and construction operations for the different types of cofferdams. It utilizes a variety of multimedia resources to teach individuals on cofferdam types, design considerations, and the typical construction procedures. It is made up of various learning activities that follow the experiential learning cycle. As shown in Figure 2, the contents of the Cofferdams can be broken down into each step of the learning cycle:



1. Step I (Why): General Objective, Preview of Cofferdams, and Design Considerations
2. Step II (What): Content and References
3. Step III (How): Design Examples
4. Step IV (What if): Assignment and Quiz

Figure 2. Course Framework

As shown in Figure 2, the system starts the instructional unit with CE and leads to RO. The student learns “why” the material is important in the first step. In the second step, students move from RO to AC. They think and learn concepts. The key question in this quadrant is “What.” In the third step, students move from thinking to doing by endeavoring to find out “how” they can solve a given problem, by doing AE based on AC that they built from the previous step. Lastly, in the fourth step, students remain active and move from AE to CE. In this step, they can teach themselves by asking “What-if” questions and do something new with the knowledge previously acquired. This completes the cycle, but the students return to concrete experience with new findings and knowledge⁷. Figure 3 shows a Cofferdam page with an image of braced cofferdams.

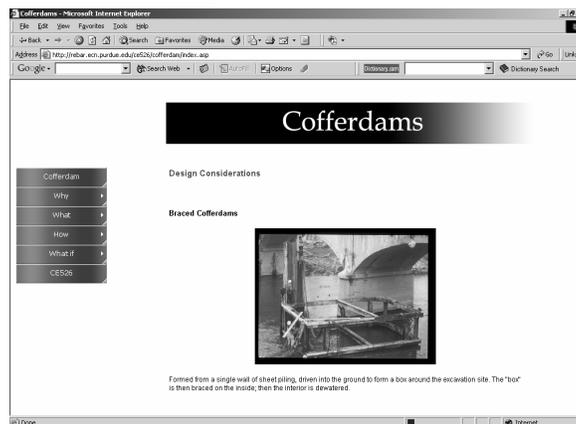


Figure 3. Example of Cofferdams⁵

Implementation

This course features a “paperless” classroom where all the course materials are in electrical format. One of the unique features of this course is the online in-class quiz. In the course of this research, the authors intended to offer a new computer-based learning approach in engineering education using wireless technology. By using the wireless technology in the classroom and Tablet PC’s, the authors provide 100% online lectures in digital format.

Having the class content in digital format helps to accommodate the ELT approach, it also allows the material to be repackaged and used in other types of education, for example in Temporary Structures Professional Development Course offered by Continuing Engineering Education at Purdue University in 2004. This course features a real-time online broadcasting.

One of the objectives in this course was to explore how on-line material could be utilized in an on campus class. The authors want to see how this approach could improve the productivity of an instructor. Therefore, this three hour course has one class time a week for one hour and fifteen minutes. Based on experiences collected, this is saving an instructor approximately three to four hours a week. With a normal teaching load of two classes, this could result in 6-8 hours a week. This is a significant improvement in productivity. The education industry is one where improved productivity has not been emphasized as much as in other industries. But with tightening resources it needs to be.

In the course of this research, an evaluation of this approach was conducted. A main issue is how this approach affects students. This was evaluated through three surveys performed during the semester. The surveys evaluated the use of digital version of ELT. Through the evaluation, feedback is collected and reviewed in several ways with the aim of improving the framework and the content as well as the application.

Evaluation

Incorporating the four steps of the learning cycle, this research conducted surveys and sought positives and negatives of Kolb’s ELT and answers to the following questions through surveys:

1. Are students comfortable taking the course by going through the learning cycle?
2. Does Step 1 assist students in understanding the importance of a particular topic? Does it encourage or motivate students to learn the topic?
3. Does Step 2 provide enough information including technical and theoretical background to understand the topic?
4. Does Step 3 provide appropriate examples and help students comprehend the concept and information they have received from the previous steps?
5. Does Step 4 assist students in provoking thoughts and testing the knowledge they have received from the previous steps?
6. Does this mode of learning meet each student’s personal learning preference?

The survey questionnaire asks how favorable each statement in the questionnaire is with respect to a level of agreement from strongly agree (SA) to strongly disagree (SD). According to the survey data, more than 82% of respondents answered they are comfortable with the learning

cycle. Looking at the learning cycle, most students have affirmative feelings that they obtain enough information and knowledge and learn the topics from Why (72%), What (68%), and How (64%). Many of them (39%), however, answered “undecided” and seem to be skeptical as to how the last step of the learning cycle, What-if, assists them in learning the topic. In addition, the last chart shows how many students think this mode of learning meets their personal learning preferences. Thirty-nine percent of the students did not agree with the statement.

In addition to observing the students’ opinions, this research implemented a hypothesis test to see if the survey result is statistically significant and to extrapolate the survey result from the test group to a larger population. This research conducted one-tailed test where the level of significance (α) is 0.05. Based on the test result, more than 50% of students agree with the statements in the questions 1, 2, and 3, but not in the questions 4, 5, and 6. Although 64% of students made affirmative responses to the question 4, it does not seem to be statistically considerable. In addition, many students still favor their own learning styles and do not tend to appreciate the others while majority of the students answered they are comfortable with the learning cycle to take in and process information.

Conclusions and Recommendations

This paper illustrates how to create a digital course that utilizes wireless technology and Kolb’s ELT that can be used in other engineering courses. The authors reviewed use of wireless devices and its technology and demonstrated how it can be utilized in design class. The course is expected to provide several contributions to higher education. It offers:

- More improved learning experiences based on the ELT.
- A digital class.
- An interactive and individualized learning program.
- A way to have a paperless class.
- A new attempt in the classroom utilizing wireless technology.
- An improved productivity for delivering educational content in a university.

As far as the use of ELT, this research found there are some needs for improvement shaping the learning approach and course delivery even though more positives than negatives are found in the evaluation. In addition, although majority of the students answered they are comfortable with the learning cycle to take in and process information, many students are still in favor of their own learning styles and do not tend to appreciate the others. According to the students’ feedback, more interactive examples and various “real-world” learning activities such as virtual field trips or multimedia demonstrations are recommended for better learning.

For the course delivery, there are some recommendations and concerns for future research. Course instructors should pay more attention to secure use of web-based applications in order to assess students’ level of understanding for each topic in a “fair” way. Also, course instructors may want to take into account providing students with more individualized learning environment by offering personalized features such as saving their quiz results in a designated place or keeping their class notes in a personal database so that they can get back to their previous lectures and quiz results later on.

Bibliography

1. Issa, Raja R.A., Cox, Robert F., and Killingsworth, Clifford F. (1999) "Impact of Multimedia-Based Instruction on Learning and Retention." *Journal of Computing in Civil Engineering*, 13 (4), 281-290.
2. Kolb, D.A. (1976) *Learning Style Inventory*. Boston: McBer.
3. Kolb, D.A. (1984) *Experiential learning: experience as the source of learning and development.*, pp. 1-38, Englewood Cliffs, New Jersey: Prentice-Hall.
4. Kolb, D.A., Boyatzis, R.E, and Mainemelis, C. (1999) "Experiential Learning Theory: Previous Research and New Directions." Department of Organizational Behavior Weatherhead School of Management Case Western Reserve University. [Online], Available: http://www.learningfromexperience.com/ELt_review_paper_rtf_rtf
5. McCullouch, Bob G. (2004) Class Note of CE526 Design of Temporary Structures. Department of Civil Engineering, Purdue University.
6. Radford, Allyn. (1997). "The Future of Multimedia in Education" [Online], Available: http://www.firstmonday.dk/issues/issue2_11/radford/
7. Wankat, Phillip C., and Frank S. Oreovicz. (1993) *Teaching Engineering*, pp. 282-305, New York: McGraw-Hill.