2006-2058: INTEGRATING FEEDBACK TECHNOLOGY INTO THE ELECTRICAL AND COMPUTER ENGINEERING CLASSROOM

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Integrating Feedback Technology into the Electrical and Computer Engineering Classroom

Abstract

Wireless Response Units have been used in the classroom in a variety of ways. This paper describes a preliminary study that notes the quality of wireless response unit use within an introductory Electrical and Computer Engineering (ECE) course at a large Midwestern research university. The initial focus of the study will concentrate on the Introduction to Digital System Design course, a course within the first year of the ECE professional program. The course is taught by two ECE faculty - a new faculty member who uses wireless response units and is teaching the course for the first time at this university, and a "seasoned" faculty member who uses traditional classroom technology and has taught the course for several years. Information about how the new faculty member integrates the wireless response units into instruction (e.g., to take attendance, to review exam questions, to supplement other technology) will be collected. Data from this study will be used to observe the impact wireless response use upon variables such as engagement, learning, and retention. From this data, future wireless response unit studies will be developed for other ECE courses.

Introduction

Technology properly integrated into the traditional classroom and laboratory community has provided instructors with the flexibility to implement innovative and effective methods of instruction and assessment. These methods have led instructors to utilize varied instructional methods that incorporate many activities that cater to many different learning style preferences. Students have a greater opportunity to interact with peers and the instructor in a technology enhanced environment.

The Introduction to Digital System Design course serves as one of the first engineering courses for many Electrical and Computer Engineering students. During this important point in a students' academic career, it is critical that the students' initial exposure to engineering is learner centered, knowledge centered, assessment centered, and community centered[1]. Wireless response units can serve as the catalyst to stimulate these interactions.

The Introduction to Digital System Design course[2] is offered by the School of Electrical and Computer Engineering. Students majoring in Electrical Engineering and Computer Engineering are required to take the course. A number of Computer Science students take the course as well to fulfill degree requirements. This four credit hour course has a weekly three hour lab that is tightly integrated with the course material covered during the three hour a week lecture.

There have been a number of studies in engineering[3] and other disciplines[4] that have reported an increase in participation when posing in-class questions via a classroom feedback system. Instructors and students report that classroom feedback systems are useful in identifying

misconceptions. Instructors also identify using classroom feedback systems as a means to promote active learning.

Methodology

A research study is being conducted on the Introduction to Digital System Design course[2] in the School of Electrical and Computer Engineering at a large Midwestern University. The Spring 2006 study examines the students' overall course performance, individual course outcome performance, students' attitude toward instruction methods, confidence in problem solving abilities, peer-to-peer interaction within the classroom, success rate, and failure rate.

There are two sections of the Introduction to Digital System Design course with a different faculty member teaching each. One of the faculty members is new to the university. The other faculty member has taught the course at the university for several years. The new faculty facilitates the section using the wireless response units. This treatment section uses the wireless response units as a means to collect formative feedback throughout the course. The control section utilizes traditional classroom technology. When registering for one of the Introduction to Digital System Design sections, students were not informed that different classroom assessment techniques were going to be used in each section. The selection process was essentially a random assignment to sections. The wireless response units are used to assess students understanding of previously discussed concepts.

Students in both sections complete the online version of the Index of Learning Styles Questionnaire developed by Ms. Barbara A. Soloman of the First-Year College, North Carolina State University, Raleigh, North Carolina and Dr. Richard M. Felder, Department of Chemical Engineering, North Carolina State University, Raleigh, North Carolina[5], and an online Myers-Briggs Type Indicator[6]. One reason for selecting the Index of Learning Styles Questionnaire instrument is because it has been proven valid and reliable when used in engineering courses. Because previous studies involving this course have used this instrument to collect data, a future study has been planned to compare the instrument results of the previous studies with this study to see if there is a correlation between instrument results and course performance. Students also complete surveys about their learning experiences with an emphasis on the learning environment (e. g. learned centered, knowledge centered, assessment centered, and community centered[1]).

Students in the treatment section are distributed School of Electrical and Computer Engineering owned wireless response units. Since wireless response unit activities facilitated through the eInstruction™ Classroom Performance System[7](CPS) are not always announced, students are encouraged to bring the wireless response units to lecture at all times.

The Introduction to Digital System Design[1] course has strong knowledge centered and assessment centered components. A balanced learning environment includes the integration of the two previously mentioned components with strong learner centered and community centered components. The challenge questions strongly emphasize actively involving the learner in the in-class learning process and building community within the classroom. The challenge questions involve students initially providing feedback individually, and then pairing with a partner to

discuss their feedback and submitting a response. Peer instruction facilitation techniques developed through Dr. Eric Mazur's Peer Instruction[9] are emphasized when using the wireless response units to help build community.

The course material is subdivided into six modules. Each module has a desired outcome. Challenge problems are developed around each outcome to anonymously probe students' understanding of the outcome. These challenge problems developed as a part of the activities facilitated through eInstruction™ CPS[7] are design around Bloom's Taxonomy[8]. Bloom's taxonomy[8] is organized into six major classes.

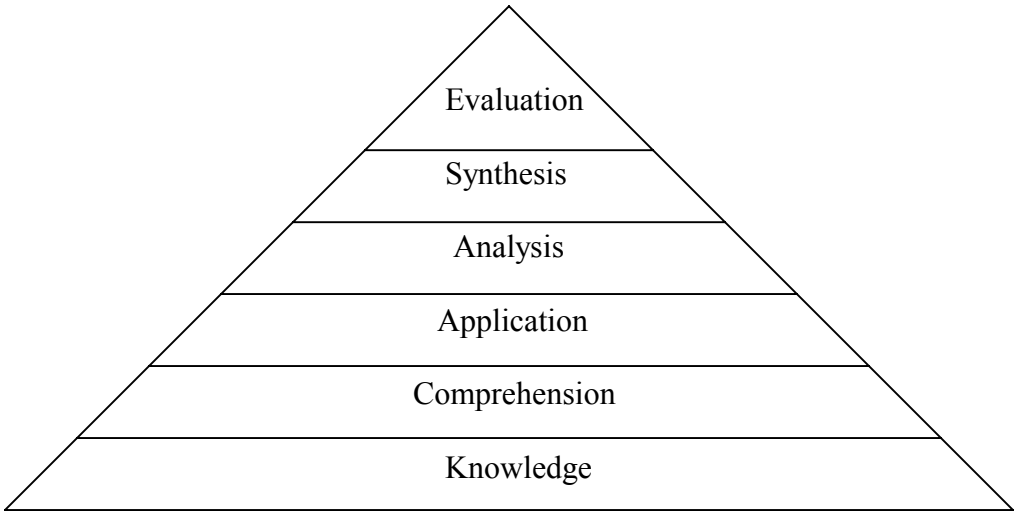

Figure 1. Graphical Representation of Bloom's Taxonomy[8]

1.0 Knowledge involves the recall of specifics and universals, the recall of methods and processes, or the recall of a pattern, structure, or setting.

2.0 Comprehension involves translation of information from one level of abstraction to another, interpretation as a configuration of ideas, and extrapolation based on understanding.

3.0 Application involves correctly demonstrating the appropriate abstraction and there exists a process for solving the problem.

4.0 Analysis involves the breakdown of the material into its constituent parts and detection of the relationships of the parts in the way they are organized.

5.0 Synthesis involves putting together elements and parts so as to form a whole in such a way as to constitute a pattern or structure not clearly there before.

6.0 Evaluation involves making judgments about the value, for some purpose, of ideas, works, solutions, methods, material, etc.

Classes 4.0 – 6.0 are considered higher-level thinking skills.

The challenge problems posed through the eInstruction™ Classroom Performance System units[7] are designed to provide students with opportunities to work problems, solidify concepts, and ask questions. A focus for the challenge problems is to address potential difficulties, deepen understanding, build confidence, and include additional questions and problems.

An independent researcher observes the peer-to-peer interactions during the class lecture through the VaNTH Observation System (VOS)[10]. The researcher observes the impact that wireless response unit use has on engagement, learning, and retention.

At the conclusion of the Spring 2006 semester, the data collected from this research study will be statistically analyzed and presented. A comparative analysis of each section's overall course performance, individual course outcome performance, students' attitude toward instruction methods, confidence in problem solving abilities, level of engagement, retention, success rate, and failure rate will be provided. Students in the treatment section will complete an additional survey pertaining to their levels of satisfaction with the course providing students with a learning environment that is learner centered, knowledge centered, assessment centered, and community centered[1].

The presentation will feature the results of the study, and provide an overview of the similarities and differences of this study as compared to other similar engineering course studies. The results and analysis of the study will be integrated into an updated version of this paper.

Bibliography

1. Bransford, John D., et al., editors, (2001) *How People Learn: Brain, Mind, Experience, and School* (Expanded edition), National Academy Press, Washington, D. C.
2. Meyer, David G., "Introduction to Digital System Design", http://shay.ecn.purdue.edu/~dsml/ece270. Last accessed on January 18, 2006.
3. Paschal, Cynthia B., (2002) "Formative Assessment In Physiology Teaching Using a Wireless Classroom Communication System", Advances in Physiology Education, Vol. 26, No. 4, pp. 299-308.
4. Fitch, James L., (2004) "Student Feedback in the College Classroom: A Technology Solution", Educational Technology Research and Development, Vol. 52, No. 1, pp. 71-81.
5. Soloman, Barbara and Richard Felder, "Index of Learning Styles Questionnaire", http://www.engr.ncsu.edu/learningstyles/ilsweb.html. Last accessed January 18, 2006.
6. Humanmetrics, "Jung – Myers-Briggs Topology Test", http://www.humanmetrics.com/cgi-win/JTypes2.asp. Last accessed January 18, 2006.
7. eInstruction™, "Classroom Performance System", http://www.einstruction.com/. Last accessed January 18, 2006.
8. Bloom, B. S. et al., (1956*) Taxonomy of Educational Objectives: The Classification of Educational Goals: Handbook 1: Cognitive Domain*, David McKay Company, New York.
9. Mazur, Eric, (1997) Peer Instruction: A User's Manual, Prentice Hall, Upper Saddle River, New Jersey.
10. Harris, A. H., *A Manual for the VaNTH Observation System*, Vanderbilt University, Nashville, TN, 2002.