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Waking the Dead: Using interactive technology to engage passive listeners in the classroom

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ABSTRACT

This research attempts to learn students perceptions about the value that Audience Response Systems add to the classroom. The technology that is the subject of this research consists of eight-button "response pads" that transmit student responses to a receiver connected to the computer in the classroom. The system allows the instructor to ask a variety of different question types and record and graphically-display the students' responses in real time. Our research reveals that while initially leery of the technology and the modest cost it adds to the course, students are generally positive about its use, and prefer courses that use the technology over those that do not. Analysis reveals that student participation approaches 100% in class sessions where PRS are used due in part to anonymity, ease of use, and the ability to see how many others answered in the same way.

Keywords

Audience Response System, active learning, interactive, eInstruction, participation, learning, classroom technology

INTRODUCTION

The use of computers in the college classroom has become so commonplace that on most campuses, it is difficult to find a classroom that does not have at least an instructor computer workstation connected to a projector. Despite the widespread availability of instructional technology, we find that traditional "Socratic" lectures are still the mainstay of college teaching, and even when the computer is used, more often than not a PowerPoint presentation has replaced the chalkboard and overhead transparencies in method of preparation and delivery but not in essence of form or content.

Many instructors are now using the Internet to provide course content and supplements to their students. Instructor web pages provide syllabus, reading and assignment schedules, descriptions of projects, cases & readings, student grades, and even chat or message board facilities. As more course content is delivered to the student digitally, we find that students no longer come to the classroom with the expectation that they will manually take pages of notes in a frantic attempt to capture the essence of the instructor's verbal monolog. As we gaze out at the sea of slouching bodies and expressionless faces from our podiums, it is hard to resist wondering if students want less education and more entertainment.

We believe that our students are just as bright and capable as those from prior generations, but that they are creating and engaging their social world in ways shaped by the technologies that surround them. These technologies are immediately interactive, and we suspect that passivity in the classroom isn't mass "couch-potato" syndrome, but instead is reflective of a group of students waiting for something they can interact with in a way with which they are familiar. Theories relating to learning suggest that modern students are primarily active learners, and that lecture/fact-memorization courses may be increasingly out of touch with how our students are learning to engage their world.

In recent years, a new type of instructional technology has emerged that has the potential to engage the rising generation of hyper-capable technology users. Called "Personal Response Systems" (PRSs), or "Audience Response Systems", these typically hand-held devices allow large groups of students to individually engage instructional content real time in the classroom and get instant feedback about their individual responses as well as seeing how the class responded as a whole. Beyond getting students more actively involved in the class, many of these systems allow a computer to automatically record student responses for grading purposes, thus providing a broader range of assessment options which might not be practical if the instructor was limited to manual methods. Many higher-education textbook publishers have begun to provide PRS at no charge to instructors who adopt their textbooks. Depending on the adoption mode, the additional cost to the student is small and is commonly included with the cost of the textbook.

In this exploratory research we study the initial use of a PRS in two survey MIS courses taught to Business Administration majors, and its ability to actively engage students in an otherwise traditional lecture setting. Overall, students report that the use of the technology adds value to the class. Log files indicate that on average 94% of the students in the classroom will attempt to answer questions during a lecture using the system. Data for this research represents a "first-use" of this technology by the authors, and the results suggest that equipment reliability and/or instructor competence significantly influences the quality of students' experience and may be biasing these initial results.

BACKGROUND

The potential of instructional technology to add value to the classroom has been recognized by Higher Education for decades (Little, 1973), (Peled, 2000). Information technologies are generally used in the classroom in one of two ways: either the technology is a tool that students are taught to use, such as an accounting program, or the technology is used by the instructor to deliver content in a traditional face-to-face environment (Rankin and Hoaas, 2001). Kryder (1999) has suggested that as students' use of computers at home and at school increases, they are becoming more "visually literate", and are more collaborative. Fowler et al. (2001) has noted that students who are skilled computer users (such as computer science majors) have a learning style that is both sensory and visual, and that 80% of *all* students are active learners. Booth (2001) explains that "good learning" increasingly is defined by an integrated set of skills rather than just memorization. Rankin and Hoaas (2001) posit that students prefer computer-facilitated education because it engages more of the senses. Marsh (1993) notes that computers have the potential to lower learning barriers for disadvantaged students. We concur and have observed that students with language difficulties are very enthusiastic about having a means of verifying their understanding of course content without having to be singled out. Despite the potential benefits of classroom technology, some researchers caution that not all subjects are suitable for "smart classroom" technologies (Raisinghani, 2000).

Thalheimer (2003) states that unless a student cognitively processes a question and participates in answering it (even if mentally), that learning does not take place. Frase et al. (1970) discovered that less-motivated students' academic performance approaches that of students who are more highly motivated when asked questions "frequently". In their survey of instructional-feedback research, Bangert-Downs et al. (1991) found that feedback is an important part of classroom learning in general. Kulhavy (1977) posits that students who received feedback before they have formulated their own answer do not learn as much as students who formulate an answer before receiving feedback. This suggests that student who do not attempt to answer questions in class learn very little from listening to the interactions of other students with the instructor. Guthrie (1971) observed that learning is significantly improved when students received corrective feedback for incorrect answers. Kulik and Kulik (1988) learned that immediate feedback resulted in more learning than delayed feedback. This suggests that students learn more from feedback relating to their answers to questions in the classroom than from feedback from graded projects and exams. Boyd (1973) observed that when students are asked more than one question about the same general "learning point" that they more easily recognize which facts are more important (improved *attention*) and retain information longer (improved *retention*).

Murphy and Riddle (2003) describe a number of technologies that can be classified as Personal Response Systems (PRSs). Most involve some kind of wireless handheld device such as a Palm Pilot, but can range from a simple eight-button "response pad" to laptop computers. Regardless of the specific design of the device, a PRS allows students to simultaneously respond to questions asked in the class in real time, and have those responses received and recorded on the instructor's computer. They suggest that PRSs work best in large classes since interaction in smaller groups can usually be managed more efficiently with manual "show of hands" techniques.

In their use of wireless keypads in large physics classes, Burnstein and Lederman (2001) found that when students' keypad responses accounted for more than 15% of the overall grade, student attendance increased dramatically, they tended to stay alert during class, and that they made "genuine" attempts to prepare for the quizzes. In a study of 6000 physics students who took a standardized test at the end of the course Hake (1998) found that students who attended a course that used a PRS scored 25% higher on the post-instruction exam than those from classes that did not use PRS technology. In her research on the usability of the eInstruction system, Copas (2004) learned that students thought the system was easy to use, "moderately" anonymous (how each person answered any particular question was anonymous to peers but not the instructor), and that they strongly preferred automated assessment methods over traditional pencil and paper methods.

The PRSs used for this research is the Classroom Performance System (CPS) by eInstruction, Inc. (http://www.eInstruction.com). This system consists of a small handheld eight-button "response pad" that transmits an infrared signal to a receiver connected to an instructor computer. Special software that is part of the CPS records student responses and outputs the results graphically in real time and saves the results for later instructor use. Response pads are purchased by students at the campus bookstore for a cost of approximately $4.00. In additional to purchasing the response

pad, students are also required to pay a $15.00 fee for registering their response pad on the eInstruction website. The registration process associates the student's personal identifying information with their individual response pad serial number and the particular course. After students have registered their response pads, the instructor imports the "roster" to the CPS database on their individual or classroom computer. CPS database files are easily copied between computers allowing the instructor to develop materials in the office or at home and transfer the materials and roster to a workstation in the classroom.

The CPS system has a utility for creating text questions with answer choices that students can select with their response pads. Question types include True/False, Yes/No, and Multiple Choice ranging from two to five possible answers/distracter combinations. Text questions and answers can be augmented with bitmap graphics. The CPS questions are displayed during a class session via computer projection. When used in conjunction with other computer presentation materials such a Microsoft PowerPoint, a CPS toolbar allows the instructor to toggle back and forth between the presentation and CPS questions and answers (note: a new release of the software provides for the integration of CPS questions with a PowerPoint presentation). An attendance feature and grade book round out a comprehensive set of reporting utilities.

RESEARCH QUESTIONS

As information technology academics we are fascinated with the latest technology inventions and our barriers to adoption are understandably low. However, as career learners immersed in college life, we are nonetheless sensitive to the impact that adopting a new classroom technology will have on our students, particularly when it increases the monetary cost of attending one of our courses. We are therefore curious to know if students feel that the benefits of the PRSs offered by our textbook publishers outweigh the cost. While the literature seems to suggest that there is the potential for improving learning in the classroom, students are cost-driven consumers and if the benefit does not outweigh the cost, given the option, students will chose other courses with which to fill their degree requirements. This leads us to ask the following questions:

- Do students believe that the use of PRSs in the classroom adds value?
- Do students believe that they participate more when PRS systems are used in the classroom?
- Do students feel that they learn more in courses that use PRSs?
- Do students feel that the value of PRSs outweigh the additional cost?
- Do students prefer courses that use PRSs?

RESEARCH HYPOTHESIS

Boyd (1973), Guthrie (1971), Kulhavy (1977) and Kulik and Kulik (1988) found that frequent questions, repetitive questions, immediate feedback, and corrective feedback all contributed significantly to student learning. The CPS used in conjunction with traditional instructional methods has the ability to significantly engage all students in even very large lecture classes in these ways. Given our belief that students are interested in learning and relatively experienced in formal educational settings, we believe that students who use the CPS will be more attentive and prepared and as a result will learn more from classroom instruction. We also expect that as young adults, college students are self-aware, particularly with regard to their performance in their classes, and we therefore expect that they will be able to recognize the effect that the use of CPS has on their classroom experience and will consequently believe that they are learning more as a result of using it. This gives rise to our first research hypotheses:

H1: ***A majority of students will believe that they have learned more as a result of using the CPS in the classroom.***

Since the CPS requires a modest cost investment, and that the students' grade in the course are at least partially reflected in their use of CPS in the classroom, we expect that students' participation will be more explicit and less spontaneous, and as a result they will be more aware of their participation. This gives rise to our second research hypothesis:

H2*: A majority of students will believe that they participate more as a result of using the CPS in the classroom.*

Our own previous educational experience coupled with daily observation leads us to believe that classes that are interactive, participatory, engaging, and insightful are more interesting and enjoyable. We therefore believe that if H1 and H2 are true, then students will believe that the use of CPS enhances the classroom experience and will therefore prefer courses that use PRSs in general. This gives rise to our third hypothesis:

H3: ***A majority of students will prefer courses that use PRSs over courses that do not use PRSs.***

At the medium size state college where this research takes place, we have observed that the use of personal information technologies is pervasive. Cell phones are ubiquitous, Compact Disk and MP3 players widespread, and notebook computers common. In many cases students appear to be investing significant amounts of money to purchase what are for the most part "luxury" items. Given the modest cost of the response pads and associated registration fee relative to other school costs and even entertainment and social expenses, we believe that students will not feel that the $20 cost for using the CPS in the classroom is excessive in light of its ability to add interest and enhance learning. This leads us to our fourth research hypothesis:

H4: ***A majority of students will believe that the value that the CPS adds to the classroom experience outweighs its monetary cost.***

RESEARCH METHODOLOGY AND DESIGN

Sproul (1988) suggests that a questionnaire is an appropriate research tool when attempting to collect information about people's "attitudes, values, beliefs, or self-reports...". DeVellis (2003) states that when a construct cannot be measured directly, then a questionnaire that contains scale items that represent the desired construct can be a useful means of measure. Since there exists no practical way of directly measuring student attitudes and beliefs, a survey was felt to be a practical and effective methodology for this research.

In our review of prior literature, we were unable to discover any existing instruments that were used to explicitly measure student attitudes towards instructional technology. Since our initial interest in this research is exploratory in nature, we chose to use a relatively simplistic survey questionnaire (see Appendix). The survey consists of twenty-three Yes/No and Multiple-Choice questions, with two subjective undirected response questions at the end. The focus of the various questions are as follows:

- Demographics: Questions 1 – 5
- Prior experience with classroom technologies: Question 6
- Ease of use: Questions 7 and 8
- Perceptions of accuracy: Questions 9 and 10
- Preferences compared to other methods: Questions 11, 12, 20
- Usage preferences: Questions 13 and 14
- Student attitudes towards CPS Questions 15 – 19, 21-25

The subjects were students enrolled in two medium-size sections of a survey MIS course which all undergraduate Business Administration students are required to take. Each of the two sections were taught by a different instructor, and the courses were ten weeks in length commencing in January 2004. Student enrollment in each section was 65 (Section C1) and 74 (Section C2) students respectively. Approximately six weeks of instruction had been completed, and five textbook chapters worth of material had been covered during that time. Classroom instruction consisted mainly of PowerPoint presentations supplemented by CPS questions during and after the lectures. In one of the sections, the CPS questions were presented during the lecture and in the other section the CPS questions were generally presented after the lecture. Some short quizzes (approximately five questions in length) had been administered and attendance was taken using the CPS at each class session. It should be noted that Section C2 experienced significant performance problems during the first several weeks of use due to suspended lighting that blocked the receivers from some students, and initially placing the receivers too close together so that a single student's response was received simultaneously by both receivers. This significant slowed the system response time, and students with weaker signals (low batteries or longer distance) could not be detected in the "noise" of the other responses. The other class (Section C1) was held in a recital hall with a wide separation of receivers, dim lighting, and clear line of site from all seats. No technical problems were encountered in this class setting. While we recognize that these technical issues jeopardize the validity of our results, we found that this unexpectedly revealed important factors relating to student perception of the value of this technology which we discuss in our results section.

The survey was administered during class time in lieu of the scheduled lecture using the CPS system. Students were told that participation was voluntary, and a brief explanation of the general nature of the questions was verbally given to the students in advance. Students were also told that they did not need to answer any question that they did not wish to. Since the CPS

system positively identifies student responses, students were asked to exchange response pads with another student while the instructor stepped out of the room to ensure anonymity.

The survey questions were projected on a screen at the front of the classroom, and students were given 1 minute to answer each question. Each question immediately followed the previous one with little or no delay. At the conclusion of the last CPS question (number 23), students were asked to answer two subjective questions on a piece of paper; what are the advantages of the system and what are the disadvantages of the system. The purpose of the question was to give students an opportunity to express any positive or negative attitudes towards the CPS not covered by the survey questions.

While the CPS system nicely produces survey reports for a single survey session, no facility exists to combine multiple sessions, so the results of the two research sessions were combined manually by exporting the result to a spreadsheets and adding the values together. Analysis of the two subjective questions was performed by recording each unique instance of a comment and adding a tally mark next to the comment when it was repeated.

RESEARCH FINDINGS

Demographics

The student sample was 55% male and 45% female with 59% that are junior level. Over 75% of the students indicated that they were adequately to moderately skilled with computers and over half had previous experience with a similar type of system. Consequently they are familiar with how these systems are used and could be possibly comparing this system to those. With this previous experience, we wanted to obtain their opinion of the system's ease of use.

Student Learning

Students' beliefs about the CPS's contributions toward learning varied significantly between the two sections. In the section where the questions were interspersed with the lecture (C1), 40% of the students believed they learned more, compared to only 8% in the section where the questions were asked at the end (C2). Student reports that the learning was the same as non-CPS courses were 48% and 39% respectively. Since C2 was also the class that experienced technical difficulties in the first weeks, we suspect that the difference in overall student perception of CPS is biased by the early technical problems rather than where the questions were asked during instruction. While the evidence is hopeful, our hypothesis H1 about student learning was only moderately supported by this research.

Participation

Participation was explored from two dimensions. While it was not an explicit research hypothesis, we were curious to discover if anonymity contributed to increased participation. The results of this research indicate that nearly half of the students (42%) felt that anonymity of their responses encouraged their participation. In fact in one of the sections a number of students subjectively identified anonymity as being a distinct advantage. While not all students appear to be worried about being judged poorly by their peers when answering incorrectly in the classroom, almost half do. The value of the CPS in creating a classroom environment where students are comfortable engaging instructional content appears to be very high. Once again, responses between the two classes varied widely. In C1 71% percent of the students indicated that they participated more compared to 33% in C2. On average 42% of the students said they participated more. These results indicate that hypothesis H2 was supported.

Preference for PRS Courses

61% of the students in C1 indicated that they would prefer PRS courses over non-PRS courses compared to 15% of students in C2. Responses to the subjective questions shed some light on these results. On the subjective questions, students in C2 frequently mentioned cost, accuracy, and technical problems as disadvantages of PRS. This confirms our belief that technical difficulties in the first weeks of this class have biased overall student perceptions of the value of the technology. When these results are combined, 33% percent of the students indicated a preference for courses that use PRS which does not support hypothesis H3.

Benefit vs. Cost

On average, only 27% of the students indicated that the benefits derived from using the PRS was worth the cost, which does not support research hypothesis H4. In C1 56% stated that the benefits outweighed the cost and 28% were neutral. In C2 only 7% believed that the benefits outweighed the cost and 30% were neutral, therefore hypothesis H4 is also not supported.

DISCUSSION

The CPS system uses a multiple-choice format for asking questions and receiving answers. While this method works very well for assessing fact memorization, it requires quite a bit of effort to devise questions that require higher-levels of reasoning and integration. There is also the issue of pacing ; more integrative questions take longer to formulate answers, and if the instructor waits for "everyone" to answer, there could be considerable delays. We are also concerned about the potential impact of substituting verbal expression in the classroom with button pressing. In our sections, the use of the CPS has not replaced the discussion portions of the class, but the potential for this to occur is real and users should be cautioned not to deprive students of opportunities to frequently practice verbal communication skills.

We found that the initial placement of the wireless receivers and fluorescent lighting caused disruption in one of the classes piloting this technology. The infrared receivers need to be placed in locations that cannot be obstructed by human bodies or other solid structures. It is also very important in large classes that the receivers be places so that the infrared signal is only received by a single receiver. In a more recent course with 160 students, wide placement of the receivers significantly increase speed, but there appears to be some delay in collecting all the scores from a large group. In general, computer speed directly affects the CPS response times. In comparing the results of Section C1 and C2, we observed that the technical problems definitely affected the students' perception of the system's accuracy and overall value, particularly since most students had no prior experience with the technology. In future research we will attempt to determine how technical issued affect students perception of assessment reliability more directly.

Our exploratory survey provided valuable insight into student perceptions of interactive technologies in general, and how those perceptions are affected by system responsiveness and accuracy. We recognize that differences between Section C1 and C2 in question placement in the lecture (during the lecture vs. at the end of the lecture), and the presence or absence of technical problems serious affects the validity of our research. However, as an exploratory study we find the evidence of these effects of great interest and are using them to develop a more rigorous study utilizing larger samples, better controls, and narrower research focus.

CONCLUSION

While we still believe that PRS technologies have a lot of promise, it is clear that student confidence is tenuous, particularly in the face of technical difficulties and instructor inexperience. Optimal physical deployment and instructor competence appear to be important factors that contribute to student perception of value. Log files indicate that student participation averages nearly 95% which is much higher than what we observe in traditional classroom settings. These results notwithstanding, less than half of the students believed they were responding more. This leads us to wonder how some students define participation and what they feel their role is in the learning process. In subsequent months we will expand our research to explore some of these issues more fully. We are particularly interested in what the literature says about question frequency and positioning in the lecture, and will make changes to our PRS usage accordingly. We are confident that with greater controls and more experience, our research will reveal consistent results that reflect more positively on the use of PRS in the classroom.

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APPENDIX – SURVEY QUESTIONS

1 Your gender is: (A) Female (B) Male
2 Your college standing is: (A) Freshman (B) Sophomore , etc. (C) – (E)
3 Which of the following best reflects your overall computer skills
(A) Very skilled (B) Moderately skilled (C) Adequately skilled (D) Not very skilled (E) Very unskilled
4 What is your Business Administration "concentration"?
(A) Acct (B) FRL (C) MHR (D) CIS (E) Other - choice is on next slide
5 What is your Business Administration "concentration"
(A) Other (choice was on previous slide) (B) TOM (C) EBIZ (D) IBM (E) Grad Student / Other
6 Which of the following reflects your experience with similar classroom technologies like WebCT or Blackboard? (Do not include this course) (A) 5+ (B) 2 – 4 (C) 1 (D) 0
7 Which of the following best reflects the ease of registering your response pad online
(A)Very difficult (B) Somewhat difficult (C) Neutral (D) Easy (E) Very Easy
8 Which of the following best reflects how difficult it was to learn to use the system
(A) Very difficult (B) Difficult (C) Neutral (D) Easy (E) Very Easy
9 Which of the following best reflects your feelings on the accuracy of attendance recording
(A) Accurate (B) Not Accurate
10 which of the following best reflects your feelings on the accuracy of quiz scores
(A) Always accurate (B) Usually accurate (C) Seldom accurate (D) Never accurate
11 I would rather take a quiz using this system than with a Scantron (A) Yes (B) No (C) Don't care
12 I think this system is more accurate than a Scantron (A) Yes (B) No (C) The same
13 How much time on average would you LIKE to answer a question?
(A) 1 min + (B) 45 sec (C) 30 sec (D) 15 sec (E) less than 15 sec
14 How much time on average do you NEED to answer a question?
(A) 1 min + (B) 45 sec (C) 30 sec (D) 15 sec (E) less than 15 sec
15 I participate more because my answers are anonymous (A) Yes (B) No
16 I like seeing how other students answer the questions (A) Yes (B) No (C) Don't care
17 Lectures are more interesting with this system (A) Yes (B) No (C) About the same
18 I participate more because of this system (A) Yes (B) No (C) About the same
19 I am learning more because of this system (A) Yes (B) No (C) About the same
20 I would prefer to take a class that uses this system over one that doesn't use the system
(A) Strongly agree (B) Agree (C) Neutral (D) Disagree (E) Strongly disagree
21 The value this system adds to the course is worth the extra cost (A) Yes (B) Neutral (C) No
22 I would like to see this system used in other courses
(A) Strongly agree (B) Agree (C) Neutral (D) Disagree (E) Strongly disagree
23 I would recommend a class that uses this system to another student (A) Yes (B) Neutral (C) No