December 2006

Embedding Student Clickers in an Introductory Management Information Systems Course

Roslin Hauck
Illinois State University

Matthew Nelson
Illinois State University

Embedding Student Clickers in an Introductory Management Information Systems Course

Roslin V. Hauck
Illinois State University
rosie.hauck@ilstu.edu

Matthew Nelson
Illinois State University
mlnelso@ilstu.edu

ABSTRACT

The challenges associated with teaching a core introductory management information systems (MIS) course are well known (large class sizes serving a majority of non-MIS majors, sustaining student interests, encouraging class participation, etc.). This study offers a mechanism towards managing and (hopefully) overcoming these challenges through the use of a simple and effective teaching innovation referred to as classroom response systems (a.k.a., clickers). Although clickers are not necessarily new (they have been around for some time), recent enhancements, such as radio-frequency technology and integration with other presentation software, have made them easier to manage, with greater reliability and flexibility. This paper presents a case study of the implementation and integration of clickers into an introductory MIS course. The system benefits, lessons learned and effective practices of integrating the technology in a large lecture format are provided.

Keywords

Classroom technology, classroom response system, Radio frequency-based system, active learning

INTRODUCTION

The challenges associated with teaching core introductory management information systems (MIS) courses are shared by many. After acclimating to the sheer size of the classroom and the volume of students (often with triple digit enrollments), the instructor must confront the larger issue of actively engaging students and sustaining their interest throughout the semester. This problem is exacerbated with the reality that a majority of students in a core introductory MIS course are non-MIS majors. This large lecture format imposes common problems that are difficult to overcome with traditional teaching practices. Taking attendance is nearly impossible, seating charts are out of the question, in-class student activities are a logistical nightmare, group projects are too time consuming to properly manage, in-class surveys are great (but who has time to count all of the hands) and the list goes on.

This paper is intended to address these challenges by presenting a real life application of an in-class, radio-frequency (RF) based classroom response system (CRS; a.k.a. "clickers") in a core introductory MIS course for business students. Although the use of clickers in a classroom is no panacea, they most certainly provide significant inroads towards managing the challenges inherent in a large lecture format course. We provide a background of research in effective teaching and learning, a case study that provides our technical implementation and integration with the course curriculum, as well as the significant benefits, lessons learned and effective practices that we discovered in the process. Rather than comparing different vendor products, we focus on specific system traits, features and practices we believe to be effective in enhancing the teaching and learning process.

BACKGROUND

A Review of Effective Learning Principles in the Classroom

Before we can discuss the technology, we should first ask ourselves what we are trying to accomplish by implementing the CRS in the classroom. The research literature on learning discusses a number of concepts that promote effective learning in the classroom. Active learning, providing feedback, increasing attention span, and motivation are the four learning principles that we identified as being particularly challenging to the large-lecture format class. *Active learning* refers to techniques that require students to actively process and apply information to learn as opposed to passive listening (Meyer & Jones, 1993). The key characteristic of active learning that makes it a powerful technique is that active engagement involves higher-order

thinking (such as analysis, synthesis, evaluation), which results in greater learning, understanding, and retention (Bonwell & Eison, 1991; Thalheimer, 2003).

Providing feedback in the classroom is another classroom technique that has been found to enhance learning (Bangert-Downs, Kulik, Kulik, & Morgan, 1991). Successful feedback in the classroom refers to providing information to the student that draws attention to the learning process, thereby improving performance in the classroom (Kluger & DeNisi, 1996). Not only is feedback important, the timing in which the feedback is given is also important. A number of studies have found that immediate feedback is more effective than delayed feedback (see e.g., Azevedo & Bernard, 1995; Kulik & Kulik, 1988). The process of giving feedback repeatedly can also help maintain student attention span.

Attention span deals with selectively attending to and extracting information from the environment (Bandura, 1986). In the learning environment, the purpose of attention is to keep students actively processing information that is relevant to the class (Anderson, 1995). Because research on attention span and learning has indicated that student attention spans average ten to eighteen minutes (Johnstone & Percival, 1976), the ability to continuously reengage students during a lecture class is an important technique to enhancing learning.

Closely related to all three of the learning concepts discussed is *student motivation*. A number of previous research studies have found that motivation can play a key role in improving performance in the classroom (see e.g., Ames & Archer, 1988; Weiner, 1990). Students who are motivated to learn do learn more than students who are not motivated (Frase, 1971). In addition to using active learning and providing feedback to increase motivation, research indicates that reducing anonymity in the classroom also provides motivation for students (Sorcinelli, 1991). Given the challenges of teaching an introductory large-lecture MIS course, it became evident that in order to incorporate some of these principles of effective learning, we needed to evaluate the use of technological innovations to support our teaching goals and to hopefully, improve performance in the classroom.

Classroom Response System (CRS) Technology Overview

The technical innovation evaluated for this study is a radio-frequency (RF) based classroom response system (CRS). A CRS traditionally consists of a receiver device (a.k.a. dongle), application software, and handheld devices (a.k.a. clickers) that students use to input responses. Dongles are installed directly in a universal serial bus (USB) slot in the instructor's PC station of a classroom. The software application can be served or (as typically the case) loaded directly on the instructor's PC station. Each student is assigned, or has purchased, a clicker that possesses a unique RF identifier. Because each clicker uniquely identifies its owner, instructors can use the data collected by the system to easily track student participation and performance. In addition, the system allows instructors to generate summary charts based on student responses that can be instantly shared with the class.

In the rest of this paper, we provide an implementation case study of the innovation, as well as lessons learned, effective teaching practices and the benefits realized through implementation and use of the system in an introductory MIS course setting.

A CASE OF IMPLEMENTING CRS IN AN INTRODUCTORY MIS COURSE

Research Setting

The case setting is a medium sized public university located in the mid-western United States with a student enrollment averaging 20,000 students and a College of Business (COB) enrollment averaging 3,200 students. During a 16-month time frame (from fall 2004 through the end of fall 2005 semester), the authors collaborated and coordinated efforts between software vendors, publisher representatives, the university network support groups (at multiple levels), the classroom technology support unit, the university bookstores, and other faculty to develop a manageable and compatible clicker solution. The CRS solution developed as a result of this study was subsequently approved and adopted as the university-wide clicker solution in December 2005.

System Development and Implementation

Requirements determination and initial system design work began in September 2004. Although many software vendors offer packaged off-the-shelf clicker solutions (most of which were evaluated for purposes of this study), our initial focus was capturing requirements from stakeholders (faculty, students, technical staff and publishers) and insuring compatibility with the university's network and classroom technology. This phase was particularly challenging since the college moved into a newly constructed facility in January 2005. A pilot system was tested in a small MIS course of 31 students from February

through April 2005. Although student feedback was overwhelmingly favorable, the system was technologically unstable and the instructor's feedback was mediocre (at best). The pilot system worked only 33% of the time, with the primary causes of failure traced back to the lack of compatibility with the new facility's classroom instructor stations and numerous problems associated with the use of an off-campus 'pooled' system administration as provided by the software vendor.

The pilot resulted in several changes to the system, including switching to on-campus system administration (as opposed to an outsourced administrator), using radio-frequency based clickers (as opposed to infrared clickers), and utilizing an application program that is highly integrated with Microsoft PowerPoint® (as opposed to a stand-alone independent application). Collectively, these changes brought dramatic improvements to the system. For example, all of the non-value added complexities of working with an outsourced administrator were eliminated (e.g. waiting for the off-site administrator's data to refresh, maintaining an uninterrupted network connection, registering the university, the course, the instructor and the students *each semester*, requiring students to share private information with an outside vendor, and many others). Although this shifted some of the system administration burden back on the instructor, it was determined that the greater control, the enhanced student privacy, and the elimination of non-value added activities far outweighed the burden. In addition, the use of RF-based clickers enabled the *clicker-to-receiver hit ratio* to dramatically rise from the 40 ~ 45% range (with infrared) to the 93 ~ 98% range (with RF). Finally, switching to an application that is integrated with Microsoft PowerPoint® made the system more user-friendly and easier to integrate into class lectures. Rather than learning an entirely new stand-alone clicker application (as was the case in the pilot test), the new system acts as an add-in program in PowerPoint®, giving the application a consistent look, feel and menu structure. This reduced the instructor's (and students) learning curve with the new system.

Integration with Course Curriculum

The updated CRS was implemented in four introductory MIS courses during the fall 2005 and spring 2006 semesters (totaling 588 students). To integrate the technology into the classroom, we utilized a number of learning activities that support the four concepts of effective learning previously discussed (i.e., active learning, feedback, attention span, and motivation).

Active learning

Lectures were enhanced to include questions pertaining to the covered material. We were able to electronically take attendance, administrator in-class quizzes, conduct surveys and integrate student questions during lectures. Students were provided an enriched active learning environment via electronic material comprehension "checks", practice exam questions, opportunities to compare their performance with that of their peers, opportunities to earn credit for active classroom participation (including regular class attendance) and many others.

Providing feedback

CRS was also used to provide instantaneous feedback regarding the correct response and the distribution of responses among the possible answers (for the entire class). The CRS lecture questions enabled us to instantly gauge learning (for each student and the entire class) and enable students to instantly gauge their comprehension (for themselves and in relation to the entire class). Our classroom policy is to NOT penalize students for incorrect responses, but to forewarn students that they may lose points for failing to participate. The proportion of course points attributable to class participation and attendance ranges from five to seven percent. Prior to CRS, this proportion was zero percent since there was no reliable and accurate means to automatically track student participation and attendance. Students were informed that the CRS questions presented during lectures are similar to those that they can expect to see on exams. Electronic attendance taking, pop sample quizzes and various student opinion surveys have also been integrated in the classroom using CRS. Similar to lecture questions, these items are prepared in CRS during normal course prep (prior to the start of class) and the results are tallied, stored and reported back to the students in a matter of seconds.

Attention span

During lectures, CRS was used extensively to conclude a topic (with summary questions), to change the pace of classes (with randomly timed student opinion surveys), and to ease transitions to a different topic (rhetorical questions to spark interest). Designing lectures so that students participate in clicker sessions two to three times per class not only requires that each student actively participate and think about the lecture material, it also serves as a way to change the rhythm of the class and prevent the lecture from becoming stagnant.

Motivation

The system also provides a means of motivating students to participate and be more interested in the class material. For example, using the system to collect and display results from thought-provoking, in-class opinion polls gives us a means of incorporating student feedback into class discussions. Although we did not penalize incorrect answers, students knew that their responses were not anonymous and that we could evaluate how they were performing in each class. To further motivate interest, consolidated results are often sub-totaled for students along various demographics (e.g. male versus females, juniors versus seniors, Accounting majors versus MIS majors, etc.). Students can also be *assigned to* or *choose a team* and the system tabulates average correct scores for each team. This adds a different type of motivation and students enjoy the friendly competition and challenge of the activity.

DISCUSSION

Our discussion is structured along three lines: the system benefits; lessons learned; and effective teaching practices discovered throughout the development, implementation and use of CRS. The system benefits discussion in this paper is supplemented with quantitative and qualitative student survey data collected during the fall 2005 semester. The lessons learned are a summary of the actions taken by the authors that we (frankly) wish we would not have taken. The effective practices are a summary of the techniques and other instructional strategies used in the integration of CRS into an introductory MIS course curriculum. Our hope is that this case study and reflective discussion will provide essential insights into the successful development and effective integration of CRS for current and future adopters.

System Benefits

CRS fundamentally changes the traditional classroom environment for both students and instructors. Perhaps one of the greatest benefits of this technology is that students are more actively engaged in lectures. Based on the student feedback (see Appendix), a majority of students felt *that the use of the clickers helped their performance in the class* (94%). A majority of the students also felt that *the effort to use the clickers was worth the benefits* (85%). Ninety-eight percent (98%) of the students felt *that the clicker technology was easy to use*. Although mandatory attendance was not required of this class, 45% of the students polled responded that *using this innovation in class provided an incentive to attend class.*

Furthermore, based on the open-ended survey questions asking students to provide their opinion on the CRS technology, students found the system *useful for self-assessment* and for *comparing their performance against that of the entire class*. The instant feedback and the ability for instructors to use the feedback to elaborate on a topic was also a benefit that students reported. The use of the system to break up the class and add interactivity enhanced attention span throughout the class period. Students also reported that the use of the technology "lightens up the classroom experience" and "feels like a game show when the audience buzzes in for answers."

From an instructor's point of view, the data collected from the classroom response system is a valuable and efficient means towards monitoring student performance. The instant feedback provides instructors the opportunity to adapt their teaching in respond to the class's immediate needs. It also enables instructors to easily and continuously monitor class and individual student performance. It provides instructors an opportunity to identify students who may be struggling before (rather than after) examinations.

Lessons Learned

The following are key lessons from the systems development, implementation and integration with course curriculum:

Avoid using an infrared-based system. In addition to the low student clicker-to-receiver hit ratio (in our case it averaged 40 to 45%), the technology is often plagued by interferences with infrared devices in the classroom and infrared devices being used in adjacent rooms. Based on our experiences these drawbacks resulted in more disruptions in a classroom setting rather than providing substantive improvements.

Avoid the use of an off-site off-campus system administrator. Initially this sounds appealing. Based on our experiences, however, this causes more problems then efficiencies. Some vendors require registration at multiple levels (the university, the course, the instructor, the students and so on) EVERY semester. Requiring students to 'register' poses unique problems since (as an instructor) you would be requiring students to share their private information with an outside vendor (e.g. name, e-mail ID, phone number, address, etc.). In addition, the vendor has access to student grades from in-class questions and quizzes.

Be prepared for a variety of unique student situations to arise during initial use. Students have long been accustomed to the inability to track attendance in large lecture courses. This fundamental student presumption is no longer valid and may take

them by surprise. Some students schedule courses fully planning to only attend class on exam days (especially if they are non-MIS majors). Other students simply refuse to purchase the clickers or the textbook. In the other extreme, some students will become terribly upset for forgetting, losing or misplacing their clickers. The key is to establish clicker classroom policies and to communicate them in the course syllabus. One effective approach towards mitigating these issues is to offer many more opportunities for participation/attendance points than actual points available (our ratio has grown to nearly 3:1). Another option is to provide in-class sign-in sheets for students forgetting their clickers.

Be cautious of new student integrity issues that emerge with the use of clickers. Although the ability to uniquely identify and record a student's response to their clicker ID is beneficial, it does raise new student integrity issues. For example, one student may bring several of his friends' clickers to class and respond for each. Other students may swap clickers during class or simply share answers prior to responding. Instructors should establish policies addressing these issues in advance and communicate the policies in the course syllabus. In addition, most clicker software products automatically tally (in real-time) the number of student responses. A periodic comparison of this tally to actual student head-count in the room would identify discrepancies. Instructors could include the use of *on-the-fly questions* based on in-class discussions that strictly adhere to student response countdown timeframes (e.g. if students only have 20 seconds to response to a question, there is little time for discussion or clicker swapping.)

Minimize the clicker cost to students. The cost to students for clicker devices can vary widely depending on several factors. Does the textbook publisher offer bundled pricing with the text and clicker? Does the software vendor charge additional fees for students reuse of the clickers on a per-semester or per-course basis? What is the bookstore's buyback/resale policy of clickers? Are the clickers compatible with multiple software products? Are the clickers Infrared or Radio Frequency based? Does the university have a campus-wide agreement with a clicker software vendor? (If so, does the university assign them to students or do they expect students to purchase their own?) We have conducted dozens of cost-benefit analyses using various scenarios. Rather then enumerate them all, here are some general rules of thumb:

- Although infrared clickers are significantly less expensive then RF, the performance problems associated with IR clickers is simply not worth the cost savings.
- Bundling clickers with textbooks offered the least expensive clicker cost to students. However, confirmation with the textbook publisher that these bundled discount programs have been formed with clicker software vendors is necessary. Confirmation that these discount programs do not preclude the local university bookstores from offering the bundling is needed (this will permit a greater volume of used textbooks to be bundled with clickers).
- Additional *per-semester* or *per-course* fees are typically only incurred when an instructor makes use of the software vendor's central administration (e.g. online registration of a student's unique clicker number through the vendor's website). The performance problems associated with these off-campus central administration services are not worth the additional cost.
- Determine if the university has established a recommended campus-wide clicker solution. Although these university-wide programs may cost students more up-front, they typically will cost students less over the longer term since the student can reuse their clicker in multiple classes.

Effective Practices

The following are effective practices that should be used during the systems development, implementation and integration with course curriculum:

Use the clickers as a real-life, real-time demonstration of an information system. The *systems thinking perspective* is traditionally one of the first concepts discussed in an introductory MIS course. The clicker system (complete with a receiver device, the application software and the student response devices) offers an excellent illustration of how various hardware and software components assembled together to form an information system.

Be prepared to explain why other answers are not correct. As instructors we tend to focus on explaining (and defending) why the appropriate response to a question is correct. As a forewarning, also be prepared to fully explain why the other answers are not correct[1]. Students can immediately lose confidence in the integrity, quality, and accuracy of the exam (and the course). One of the best practices to fully explain incorrect responses is to rule-out the incorrect answers in front of the entire class. Only then do we reveal the correct answer and how the class responded to the question. This provides essential

[1] There is really nothing like an instructor fumbling around, attempting to defend why answers are incorrect, while in front of a few hundred students.

insights and key exam preparation tactics for students and is one of the greatest points of positive feedback regarding the system.

Utilize in-class virtual break-out groups to stir motivation and competition. For example, most clicker software products enable student responses to be categorized along a variety of demographics (males versus females, by major, by class, etc.) and accumulate scores throughout a session. Thus, in-class questions pertaining to the privacy / ethics chapter could pin the different majors against one another (accountants versus finance versus management versus MIS). In-class questions pertaining to the e-commerce chapter could be used to examine differences between male versus female students. It is clear that break-out groups can be used effectively to encourage variety in the approach to teaching and to sustain student interest, with an enjoyable, enriched active learning environment.

Wait a semester prior to heavy allocation of course points to clicker-based activities. It may take a semester (or two) before an instructor becomes comfortable with using the system and the system becomes fully compatible with the technical environment. Thus, for the first semester (or two) we recommend allocating a small amount of participation / attendance points (5 to 7 percent of the overall course grade) associated with the student's use of the system. As the instructor gains confidence in the system's dependability as well as the in the learning activities using the technology, he or she can then consider increasing the points and the associated activities (in-class quizzes, group break-out sessions, etc.).

Take student opinion polls. The IT industry is changing at an increasing rate. Countless controversial news stories emerge on a daily basis in matters concerning personal privacy, ethics, SPAM mail, viruses, new product launches, new website launches, search engines, IT vendors and so on. Use the system to take the temperature of student opinions on these controversial subjects and be sure to show the results to the class. These simple polls are an excellent means of transitioning to different lecture topics, changing the pace of the lecture, and grabbing attention at the start of a class.

CONCLUSIONS

The intent of this study is to assist instructors with managing teaching challenges inherent to large lecture course via an enriched learning environment using an electronic classroom response "clicker" system. We provided an implementation case study of the innovation, as well as lessons learned, effective teaching practices and the benefits realized through implementation and use of the system in an introductory MIS course setting. Our hope is that this case and reflective discussion will provide essential insights into the successful development and effective integration of CRS for current and future adopters.

ACKNOWLEDGMENTS

We would like to thank Dr. Gerry McKean and several reviewers for their feedback on earlier drafts of this paper.

REFERENCES

1. Ames, C. & Archer, J. (1988) Achievement goals in the classroom: Students' learning strategies and motivation processes, *Journal of Educational Psychology*, 80, 3, 260-267.
2. Anderson, J.R. (1995) Cognitive psychology and its implications, 4th ed., Freedman, NY.
3. Azevedo, R. and Bernard, R. M. (1995) A meta-analysis of the effects of feedback in computer-based instruction. *Journal of Educational Computing Research*, 13, 2, 111-127.
4. Bandura, A. (1986) Social foundations of thought and action: A Social cognitive Theory. Prentice Hall: Englewood Cliffs, NJ.
5. Bangert-Downs, R. L., Kulik, C. C., Kulik, J. A., and Morgan, M.T. (1991) The instructional effect of feedback in test-like events, *Review of Educational Research*, 61,2, 213-238.
6. Bonwell, C.C., and Eison, J.A. (1991) Active learning: Creating excitement in the classroom, ASHE-ERIC Higher Education Report No. 1. Washington, DC: The George Washington University, School of Education and Human Development.
7. Frase, L. T. (1971) Effect of incentive variables and type of adjunct question upon text learning. *Journal of Educational Psychology*, 58, 266-272.
8. Guthrie, R. W. and Carlin, A. (2004) Waking the dead: Using interactive technology to engage passive listeners in the classroom. *Proceedings of the 10th Americas Conference in Information Systems*, August, New York, NY.
9. Johnstone, A. H. and Percival, F. (1976) Attention breaks in lectures. *Education in chemistry*, 13, 49-50.

10. Kluger, A. N. and DeNisi, A. (1996) The effects of feedback interventions on performance: A historical review, meta-analysis, and a preliminary feedback intervention theory, *Psychological Bulletin*, 119, 254-284.
11. Kulik, J. A., and Kulik, C. C. (1988) Timing of feedback and verbal learning, *Review of Educational Research*, 58, 1, 79-97.
12. Meyers, C. and Jones, T.B. (1993) Promoting Active Learning: Strategies for the College Classroom, Jossey-Bass Inc., SF.
13. Penner, J. G. (1984) Why many college teachers cannot lecture. Thomas:, Springfield.
14. Sorcinelli, M. D. (1991) Research findings on the seven principles, *New directions for teaching and learning*, 47, 13-25.
15. Thalheimer, W. (2003) The learning benefits of questions, Retrieved February 17, 2006, from http://www.work-learning.com/ma/PP_WP003.asp
16. Weiner, B. (1990) History of motivational research in education, *Journal of educational research*, 82, 616-622.

APPENDIX – STUDENT SURVEY RESULTS (N = 58)

1.) I feel that using clickers helps my performance in this class.	**Responses**
Strongly agree	35%
Agree	59%
Neutral	6%
Disagree	0%
Strongly disagree	0%
Total	**100%**

2.) I feel that using the clickers in class is worth the time and effort.	**Responses**
Strongly agree	40%
Agree	45%
Neutral	12%
Disagree	3%
Strongly disagree	0%
Total	**100%**

3.) The clickers are easy to use.	**Responses**
Strongly agree	81%
Agree	17%
Neutral	0%
Disagree	2%
Strongly disagree	0%
Total	**100%**

4.) I probably attend class more because of the clickers.	**Responses**
Strongly agree	14%

Agree	31%
Neutral	38%
Disagree	14%
Strongly disagree	3%
Total	**100%**