Software-Based Student Response Systems: An Interdisciplinary Initiative

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ABSTRACT

Colleagues from information technology and three academic departments collaborated on an instructional technology initiative to employ student response systems in classes in mathematics, accounting and education. The instructors assessed the viability of using software-based systems to enable students to use their own devices (cell phones, tablets, laptop computers) rather than relying on dedicated devices needed with a hardware-based student response system. The instructors also evaluated student reaction to the technology and share their perceptions about the pedagogy, noting that all three felt there was a positive effect on student engagement. Finally, the instructors reflect on the long-term impact of the initiative on their teaching.

INTRODUCTION

Student response systems (also known more informally as "clickers") have been used in higher education for over a decade, with promising results in many disciplines. Research has demonstrated that such systems increase both student engagement and learning, while leveling the playing field by inviting participation by all members of a class. The findings have been consistent across levels (introductory, advanced, undergraduate, and graduate courses), class sizes, and academic disciplines (Sevian & Robinson, 2011; Kay & LeSage, 2009).

However, student response systems impose costs on institutions where they are adopted. Faculty training is needed to ensure that the systems are used effectively, and course revisions must be implemented to integrate the devices. Dedicated devices have a cost, which is borne either directly by the students or the institution. In addition, Information Technology (IT) departments incur costs in responding to faculty and student issues. While the initial introduction of student response systems involved dedicated devices, online alternatives have been available for several years, enabling faculty to adopt a student response system that uses devices such as cell phones, tablets and laptops.

This paper presents an instructional technology initiative at a small private university, where three faculty members in different disciplines piloted "bring your own device"

solutions as an alternative to a dedicated hardware-based student response system. The paper contributes to the literature by describing a successful collaboration among IT staff members and faculty members from different schools at the university. It also provides anecdotal evidence that software-based student response systems can be used effectively in place of hardware-based systems, potentially providing cost savings. The finding that three instructors with different teaching styles were able to use the same technology to engage students—and have continued to employ the technology after the formal initiative—provides evidence that collaborations across academic disciplines and with support from IT can benefit faculty by helping them to develop effective pedagogies. In addition to sharing our experiences in collaborating to improve teaching through technology, we also offer insights into the adoption of software-based student response systems to replace a hardware-based system.

In this paper, we first describe the emergence of student response systems as a mainstream technology tool in the university classroom and provide a brief literature review. In the second section, we describe the initiative, discuss the rationale, and identify the participants, the methodology and the results. The final section discusses conclusions and implications for practice.

LITERATURE REVIEW

Student Engagement and Student Response Systems

Student engagement is widely viewed as a critical element in fostering successful outcomes in higher education. Educational research has demonstrated the importance of student engagement, and the publication of Student Success in College: Creating Conditions that Matter (Kuh et al., 2005) brought the language and elements of student engagement to the forefront of discussions throughout higher education. Research supports the assertion that students report higher levels of engagement when faculty members use active and collaborative learning (Umbach & Wawrzynski 2005). The adoption of cooperative learning practices, the movement from "sage on the stage" to "guide on the side," and the trend toward flipped classrooms have all grown from a desire to increase student engagement and improve learning outcomes.

The use of student response systems represents one technique that has gained traction as faculty members seek to implement active learning practices to engage students and support learning. The first commercial audience response systems were hardware-based systems that required the purchase of hand-held units that were used to input responses to questions posed by the instructor. As such systems grew in popularity, developers created alternative software-based systems, which make use of the students' own devices. Such systems are web-based and typically require either a cell phone with texting capabilities or a device that can access the Internet.

Regardless of the type of system adopted, the purpose of using a student response system is to enhance student engagement and improve learning. Thus, a key question is the extent to which these systems are effective. Several literature reviews have summarized studies from different disciplines and concluded that student response systems are well received by students, increase engagement and improve learning outcomes (Kay & LeSage, 2009). However, the literature on efficacy of student response systems does not distinguish among different types of systems (hardware-based vs. software-based). Since both types of systems provide essentially the same functionality, the choice appears to be a matter of preference and budgetary constraints.

The Bring Your Own Device (BYOD) movement, began as a strategy to encourage employees to utilize personal electronic devices in the workplace (Burns-Sardone, 2014). Employee laptops, tablet computers and smartphones are examples of the types of technologies typically seen in a BYOD program (Burns-Sardone, 2014). Encouraging employees to bring and use their own devices provides organizations with several potential advantages including a reduction in technology acquisition expenses as well as increased employee comfort with technology (Afreen, 2014).

BYOD is becoming increasingly popular in support of students at educational institutions (Burns-Sardone, 2014; DiFilipo & Kondrach, 2012). The BYOD trend has even been seen in K-12 school districts (Burns-Sardone, 2014), suggesting that the expectation among students for support for BYOD from higher education institutions may continue to grow.

In a recent study of U.S. undergraduate students, Dahlstrom et. al. (2013) found that 89% of students own a laptop computer and 39% own a tablet computer. The prevalence of easy access to the Internet on college campuses has resulted in many students using their laptops for a variety of daily tasks, including as an instrument in support of classroom instruction (Kay, 2012). While not as widespread as laptops, tablet computers are quickly gaining in ownership among U.S. undergraduate students (Dahlstrom et al., 2013). Indeed, Dahlstrom et al. (2013) found that "... tablets grew the most in terms of academic use compared with all other devices..." (p. 27).

The rate of smartphone ownership among U.S. undergraduate students continues to increase (Dahlstrom et al., 2013). In a survey of U.S. undergraduate students, Dahlstrom et al. (2013) found that 76% reported owning a smartphone in 2013 compared with 62% in 2012. Similarly, in a survey study of 403 undergraduate students, Emanuel (2013) found 85% reported owning a smartphone.

At the institution where this initiative took place students were surveyed regarding device ownership during the 2014 spring semester. Among the survey respondents 99% reported owning a computer, with 96% of computer owners reporting their primary computing device as a laptop computer. More than 90% reported that they owned a smartphone and 35% of the respondents owned a tablet.

As college students are increasingly likely to own one or more mobile technology devices, college instructors may consider asking students to use their own devices as classroom response systems (Haintz et al., 2014). Leveraging students' personal devices as response system devices offers several advantages including improved student engagement, cost savings, and increased support for the spontaneous use of response system technology (Afreen, 2014; Good, 2013; Haintz et al, 2014). Fortunately students have been found to be both ready and willing to use their smartphones in this capacity (Dahlstrom et al., 2013).

Traditional classroom response systems are hardware devices that must be configured for each individual classroom and distributed to students prior to use (Lee et al., 2013). This requires considerable planning in order to utilize the devices in the classroom. Additionally, the hardware-based response systems are limited by the number of available "clickers" (Lee et al., 2013). Software-based response systems, by contrast, do not require a student to bring a separate response system device to class (Smith-Stoner, 2012). Rather, students are able to use their own devices to interact with a software-based response system. In addition to enabling a greater level of spontaneity in use of the response system, this approach does not rely on either students remembering to bring a hardware-based "clicker" to class or an instructor handing them out prior to class.

Finally, hardware-based student response systems require investment in the hand-held "clicker" devices (Good, 2013, Lee et al., 2013). Using a software-based response system eliminates the cost of the specialized devices. Institutions may elect to move to a software-based system as part of a cost savings initiative (Afreen, 2014).

METHODOLOGY

This study was conducted during the fall 2012 semester at a small, private northeastern liberal arts university. Hardware-based student response systems had been used at this institution for a number of years. The university's IT staff partnered with three instructors to determine the instructors' perceptions of the efficacy of software-based student response systems.

Several software-based clicker systems were considered.. The participants met prior to the start of the semester to discuss how such systems could be used to support instruction and to preview a variety of different software-based clicker systems. The systems selected for this study were Socrative and Top Hat Monocle (now known as Top Hat). Socrative was chosen for its as ease of use and because there was no cost. Top Hat was chosen for its robust feature set as well as ability to support cell phone text responses.

The participating instructors all had over twenty years of teaching experience and hailed from three different disciplines: mathematics, business and education. Each instructor utilized software-based clicker systems in face-to-face undergraduate courses during the semester; all three used Socrative, two also used Top Hat. Student access to appropriate devices was not an issue in any of their classes.

The participants met several times during the semester to share their experiences. Since the instructors utilized the technology in different ways, these meetings allowed them to generate new pedagogical ideas for how to use the clicker systems in class. IT provided advice and support on any technical issues the instructors were experiencing. At the end of the semester the participants co-hosted a university forum to share their experience with their peers.

In the following sections the instructors each share their qualitative impressions of the software solutions. Each instructor paid particular attention to the extent to which the systems were supported by hardware being brought into the classroom by their students; were easy to use; and impacted student engagement. In addition, the instructors assessed the general sentiment of their students towards these systems.

Student Response Systems, Mathematics

The mathematics professor in the initiative used Socrative in two sections of Mathematics for Elementary Education I. Most students were freshmen, but there were a significant number of upperclassmen, mainly sophomores. During class time, the professor used an assortment of methods including lecture (incorporating questions and class discussion), group activities, graded activities, and exams. The professor had no previous experience with student response systems.

Through Socrative, the professor created and saved multiple choice or short answer quizzes. The quizzes were used to spot check knowledge of definitions and concepts previously covered. Eight quizzes were given over the course of the semester. The instructor allowed collaboration on the quizzes in case students needed to share devices, although some students passed devices on so that they could work independently. Usually this did not cause a problem with the activity lasting too long, but whether to insist that each student work alone, and therefore likely needing devices to be passed on, or allowing collaboration is something to consider when planning. The quizzes were counted toward the class participation segment of the course grade and the scores, which were emailed to the instructor as an Excel spreadsheet, were used as a formative assessment.

A strength of Socrative is that it can be learned easily and quickly through exploring the various options in the program, with no guidance other than the help that the program provides. The professor had considered using Top Hat in addition to Socrative to compare the two systems, but it quickly became apparent that Top Hat was not as intuitive to learn and would require significantly more time to master. Therefore, she chose to use only Socrative.

The professor was skeptical as to what utility Socrative would provide in her courses and, not being a technology enthusiast, she had anxieties over using technology that was new to her. However, she found that the Socrative quizzes were an effective means to provide in-class review of basic ideas. Socrative lent itself well to relatively simple questions aimed at assessing factual knowledge and basic reasoning or computation. The professor's preference was to open class with a quiz, but she also used a quiz midway through class as a way to break things up (the class period was seventy-five minutes). As the semester progressed, her comfort level with the software grew.

An issue that instructors face when using any student response system is balancing its use with other important class activities. Even a short five-question Socrative quiz required at least ten to fifteen minutes, once review of the answers and discussion is factored in. Assessing a student's mathematical reasoning or ability to communicate a complex mathematical idea is not easily accomplished through Socrative, and is probably best left to other means.

Based on the comments from the course evaluations, students seemed to enjoy the Socrative quizzes as a mode of class participation. The level of engagement and enjoyment the student response systems appear to provide is a benefit, especially in mathematics classes where many students are anxious. Although the professor has continued to use Socrative quizzes in her classes, she is using them less often than in the initial semester. The reason is to balance basic activities, such as the Socrative quizzes, with activities that require higher level reasoning. In future semesters, the professor intends to explore other modalities of Socrative, such as posing a statement or question as a springboard for discussion.

Student Response Systems in Intermediate Accounting

The accounting professor who participated in the initiative was comfortable with technology, as she had been using a hardware-based student response system for several years, and integrated presentation and spreadsheet software and online tools (e.g., quizzes and discussion forum) in her face-to-face classes. She adopted the BYOD alternatives for two sections of Intermediate Accounting I, with a total of 65 students, most of whom were juniors or seniors.

The instructor's typical teaching style was to combine lecture with in-class exercises, including both group and individual activities. The instructor had been using Turning Point, a hardware-based system for several semesters. The university owned the devices and so they were available. During the semester, the instructor continued to use Turning Point, and added Socrative and Top Hat. All three were used for review and reinforcement during lectures, and Socrative was also used for group quizzes in class. To avoid confusion on the part of the instructor and students, only one student response system was used during any single class period.

During most lectures, the instructor included periodic "clicker" questions to assess student understanding of key concepts and afford students practice in applying these concepts to solve brief problems. When Turning Point was used, devices were distributed by the instructor and students worked independently; when the software-based systems were used, students worked in pairs or small groups (to ensure that all students could participate) and used their own devices.

The adoption of Socrative was very easy. The software was intuitive, flexible, and easy for both the instructor and the students to access. Since it allowed for open-ended questions, Socrative was ideal for group-based quizzes, in which students discussed a question and framed a brief response. The adoption of Top Hat required a greater investment of time. The customer support was excellent, which enabled the instructor to work through the development of multiple sets of questions to be inserted into lectures at appropriate points. However, Top Hat is a very comprehensive program, which can also function as a stand-alone course management system. Thus, it is more complex and (from the instructor's perspective) more complicated to use. Thus, the instructor tended to rely more heavily on Turning Point (the hardware-based system) and Socrative (the software-based system) for clicker-based activities.

Student response to the different student response systems was generally very positive. The students experienced very few technical issues, and those that arose were easily resolved. Many students provided unsolicited positive feedback during the semester. While the novelty of using the devices – and being allowed to use cell phones during class – may have held an initial appeal to the students, the real benefit of the technology was the requirement to regularly reflect on key points, discuss concepts with other students, and apply the material to solve problems. Although there was not a specific question about the student response systems on the course evaluation, several students made favorable comments regarding the technology in the student evaluations.

The instructor greatly appreciated the flexibility afforded by the software-based systems. Not only was she freed from the task of carrying devices to class, there was a time savings from no longer distributing and collecting the devices at the beginning and end of class, and she was able to spontaneously ask clicker questions to check student understanding. The instructor has continued to use both Turning Point and Socrative in the following years, and has used these systems in all of the courses that she teaches. As the percentage of students who own smart phones and/or tablets has increased, this instructor has moved toward greater reliance on Socrative rather than Turning Point. In addition to increasing the use of student response systems in class, this initiative also helped the instructor to think more deeply about student learning and the importance of using technology to foster engagement with the content. The "wow factor" is short-lived, but the deep thinking required when students are actively engaged during class contributes toward improved learning.

Teaching Students Who Will Be Teachers

"Good Morning, let's get started. Take out your phones, please." Looks of confusion greet that class opening. The instructor can "hear" them thinking "she hates it when we have our phones out. What's going on?" But they dutifully take out their phones and we get started.

The education professor involved in this initiative has an academic background in curriculum and instruction with an emphasis in educational computing. She is a regular user of technology to support teaching and learning, frequently using SmartBoard apps, presentation software and iPads. Although this instructor has been an early adopter of most technologies, she maintained a "no personal use of cell phones" policy in her classes. College students often use their cell phones in the classroom for texting, surfing the web, and other non-instructional purposes. Rather than ignore reality, this instructor has turned the use of cell phones toward learning, having students use them for "Google moments" during instruction and discussions.

This professor used student response systems in three junior-level classes in Education, taught as a three-course block, so the same dozen students were in all three classes. The class content is a combination of educational theory and pedagogy and therefore, it is incumbent upon the instructor to model the use of a variety of teaching strategies, and it is especially important that she demonstrate flexibility when a tool does not work or there is a network outage. Some form of technology is used in almost every class and assignments require considerable use of technology tools.

Prior to this project, this instructor had used a variety of student response systems, including Socrative and Poll EveryWhere (another software-only system) and Turning Point. For this initiative, Top Hat and Socrative were used. Both systems were used in similar ways. Both allow preparation of multiple choice and true/false quizzes. Socrative offers the ability to ask for open-ended responses. Top Hat and Socrative were equally easy for students to access and use. It was fairly easy to develop quizzes in both programs, but this instructor found Socrative to be much faster for this purpose.

Quizzes were frequently given at the beginning of class as a check-in on assigned reading. These were ready for the students to take as they arrived at class, using those first few organizational minutes. Graded content quizzes were given and often those involved students working in pairs. When using Socrative, the open-ended option was used frequently, providing an opportunity for students working in pairs or trios to encourage them to discuss and come to consensus on a response. This proved to be an activity well-received by the students.

Socrative allows anonymous, spontaneous questions to be posed during class, and this was was used frequently. The instructor generally monitored responses on a laptop or tablet and projected the graph of responses in real time so the students could see how the class was responding.

The positive responses that accompanied a "take out your phone" request never waned. Students liked working in pairs, and the instructor found that paired activities resulted in some questioning and discussion that was richer than class discussions without the presence of technology. Perhaps this is as a result of the private discussion between two students followed by a full-class discussion.

The student response technology was not used in every class – and not even every week. This instructor found it

to be a positive regular addition to her toolkit of instructional strategies. Although both systems were reasonably accessible, this instructor found that Socrative was easier and faster both for developing activities and for students to access. Socrative is the system that has continued to be used.

Varying instructional strategies is important for student learning. Engaging students during class can only enhance that learning. And turning the ever-present cell phone into a tool for classroom engagement can't hurt.

Discussion and Conclusions

Although the three instructors who participated in this initiative come from different disciplines and have different teaching styles, each found ways to use software-based student response systems in their courses. This initiative was not designed to measure the impact of response systems on student learning, but it was clear that the students responded positively to these interactive activities; all three instructors saw an increase in student engagement. All three instrucors preferred Socrative for its ease of use, flexibility, and powerful reporting tools. Socrative makes sharing devices easy by allowing students to enter more than one name as they begin an activity, allowing collaboration. Another Socrative feature is that quizzes can be restarted for another student without having to exit and re-enter the program. Therefore a device can be passed from one student to another, allowing all students to complete the activity independently. Finally, the adoption of this system frees the university (or students) from the need to purchase dedicated clicker devices, and enables instructors to insert polling questions spontaneously, if desired. Importantly, all three instructors have continued to use Socrative, an indication that this technology is worthwhile addition to an instructor's teaching strategies. Based on our discussions with one another, we offer the following suggestions to those who plan to adopt this technology.

Having students pair or team up for these activities may seem counterintuitive. They are called "student" response systems after all. While individual response is often preferred, grouping students has advantages. First, it solves the "my phone isn't working" problem. More importantly, it allows for variety in the types of questions and activities that can be conducted using the student response system. Because you can ask a question where students can enter their names, you can still know whose work is being recorded. As reported here, both approaches can work.

Each of the cases reported in this paper used both graded and ungraded activities and both have a place. Quick "check-ins" during class can help the flow for a professor who is willing to take alternative paths through a class. Beginning-of-class Q & A can encourage student preparation. Using response systems for graded quizzes or tests – especially short ones – can be especially useful. Because they are scored by the software, there is no additional grading burden; further, students get more feedback (about their own performance and how it compares to others in the class) and faculty get more information about how well students are mastering the course material. This is a distinct advantage of this instructional approach.

Using prepared activities and quizzes is probably the most common way student response systems are used, and that may be the most time-efficient use both in terms of actual class time and grading. However, the anonymous polling feature of Socrative adds the ability to make class time more interactive while providing instructors with feedback at critical points during a lecture or other class activity. Once both instructors and students are comfortable with the technology, spontaneous use becomes quite quick.

On this campus, the rapid increase in the number of students with smartphones and tablets has made the use of software-based response systems the way to go. Careful consideration must be taken before using this approach for required or graded activities. If an instructor uses the system for individually graded activities, it is advisable to have extra devices available for students without their own. Battery power and malfunctions must also be considered in any high-stakes use (which even a graded quiz can be).

Of course the most important consideration is student learning. Active engagement during class is one way to keep students on task. The students involved in this pilot responded positively to the introduction of student response systems. Rather than thinking of student response systems as introducing a new technology into the classroom, think of it as gaining more time on task.

REFERENCES

Afreen, R. (2014). Bring your own device (BYOD) in higher education: Opportunities and challenges. *International Journal of Emerging Trends & Technology in Computer Science, 3*(1), 233-236.

Burns-Sardone, N. (2014). Making the case for BYOD instruction in teacher education. *Issues in Informing Science and Information Technology*, 11(1), 192-200.

Dahlstrom, E., Walker, J.D., & Dziuban, C. (2013). ECAR study of undergraduate student and information technology, 2013. Louisville, CO: EDUCAUSE Center for Analysis and Research, Retrieved from http://www.educause.edu/library/resources/ecar-study-undergraduate-students-and-information-technology-2013.

DiFilipo, S., & Kondrach, C . (2012). Rolling out a BYOD (Bring Your Own Device) program. *EDUCAUSE webinar. Retrieved from:* http://www.educause.edu/library/resources/rolling-out-byod-bring-your-own-device-program

Emanuel, R. C. (2013). The American College Student Cell Phone Survey.*College Student Journal*, *47*(1), 75-81.

Good, K.C. (2013). Audience response systems in higher education courses: A critical review of the literature. *International Journal of Instructional Technology and Distance Learning*, *10*(5), 19-34.

Haintz, C., Pichler, K., & Ebner, M. (2014). Developing a web-based question-driven audience response system supporting BYOD. *Journal of Universal Computer Science*, 20(1), 39-56.

Kay, R. (2012). Exploring the Use of Laptops in Higher Education: An Analysis of Benefits and Distractions. In T. Bastiaens & G. Marks (Eds.), Proceedings of World Conference on E-Learning in Corporate, Government, Healthcare, and Higher Education 2012 (pp. 630-635). Chesapeake, VA: AACE. Retrieved June 13, 2014 from http://www.editlib.org/p/41661.

Kay, R. & LeSage, A. (2009). Examining the benefits and challenges of using audience response systems: A review of the literature. *Computers & Education*, 53(3), 819-827.

Kuh, G.D., Kinzie, J., Schuh, J.H., Whitt, E.J. & Associates. (2005). Student Success in College: Creating Conditions that Matter. Jossey-Bass. San Francisco, CA.

Lee, A. W., Ng, J. K., Wong, E. Y., Tan, A., Lau, A. K., & Lai, S. F. (2013). Lecture rule no. 1: Cell phones on, please! A low-cost personal response system for learning and teaching. *Journal of Chemical Education*, 90(3), 388-389.

Smith-Stoner, M. (2012). Class is about to start: Please turn on your cell phones: 10 uses for cell phones in nursing education. *Teaching and Learning in Nursking*, 7, 42-46.

Sevian, H. & Robinson, W.E. (2011). Clickers promote learning in all kinds of classes-small and large, graduate and undergraduate, lecture and lab. *Journal of College Science Teaching*, 40(3), 14-18.

Umbach, P.D. & Wawrzynski, M.R. (2005). Faculty do matter: The role of college faculty in learning and engagement. *Research in Higher Education*, 46(2), 153-184.