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The iPad Pilot Project: A Faculty Driven Effort to Use Mobile Technology in the Reinvention of the Liberal Arts

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Abstract: Mobile technology is pervasive in society and in particular among young people. The use of such technology in the classroom can be controversial, and case studies and data on student perceptions of the technology are rare. This study presents the results of an iPad Pilot Project sponsored by a college at mid-sized university in the intermountain western United States. The study intersects the use of the iPad in the classroom with the reinvention of liberal arts education. Using case studies and student perceptions from survey data, the study concludes that the innovative use of the iPads in the classroom can enhance critical thinking, student collaboration, and classroom participation. The study also details some different pedagogical challenges of using the iPad in the classroom.

Keywords: iPads, mobile technology, pedagogy

Introduction

While collaboration (George, 1994), critical thinking (Grossman, 1994), and (today) brain based learning (Bowman, Frame & Kennette, 2013) are regularly thought of as key elements of the college classroom, it is rare that these three essential elements of teaching are discussed within the context of mobile learning. In fact, to many faculty members, technology inhibits collaboration, critical thinking, and student learning. Yet with the exception of one study (Diemer, Fernandez, & Streepey, 2012), there has been little empirical research on how iPads influence student perceptions of learning and engagement and how faculty members teaching with iPads deal with the pedagogical challenges arising with their use. The iPad Pilot Project (iPP) at Idaho State University seeks to answer some of the questions that the use of technology has raised in higher education.

The iPP began with the idea that all students need exposure to technology as a collaborative and problem-solving tool that complements (not replaces) human interaction. The iPP also began with the simultaneous ideas that the use of mobile technology had to be driven from the grassroots through faculty experimentation and discussion of the use of the technology in the classroom.

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Background

There is a common misconception that technology and a liberal arts education are on two opposite ends of a continuum. The liberal arts classrooms are, by design, intensely interactive, and some instructors see technology as interfering with the faculty/student interaction. Faculty in the iPP, however, saw the potential of leveraging technology in the liberal arts to facilitate student engagement and further develop the foundational skills that are critical for a quality undergraduate education. Recently, the importance of a liberal arts education, as opposed to narrowly focused technological training has been a topic of significant discussion in academic circles, including the *Chronicle of Higher Education* (Beecroft, 2013; Berman, 2013; Berrett, 2013) and *Association of American Colleges & Universities* (Humphreys & Kelly, 2014), and in nonacademic circles, including the *Wall Street Journal* (Cappelli, 2013) and *New York Times* (Brooks, 2013; Klinkenborg, 2013). These studies conclude that there is an immediate need in U.S. society for college graduates with strong critical thinking skills, clear communication skills, creative problem-solving skills, career-related skills (which often includes technological skills), cultural competency, and the ability to collaborate. (These are often referred to in our College as the six "Cs."). In other words, employers are looking for graduates with an intellectual profile and transformative skills that will prepare them to operate successfully in a global society and meet workforce expectations into the future. As educators, we need to identify strategies to integrate foundational critical liberal arts abilities such as critical thinking, collaborative learning, and technological skills to better prepare students for a broad range of careers.

The Project

In the spring of 2013, the College of Arts & Letters at Idaho State University launched the iPP as an experiment to encourage liberal arts faculty members in the humanities, fine arts, and social sciences to introduce mobile technology into their classrooms. Our project goals included seeing how instructors could use technology to deepen their students' understanding of their disciplines, how students could interact in more meaningful ways with the academic material and with each other, and how faculty could use technology to solve pedagogical challenges. This paper presents case studies and data from the project including how different instructors used this technology, the pedagogical foundation that guided them, the results that they observe, and student perceptions of the iPP.

Kandi Turley-Ames, Dean of the College of Arts & Letters, Associate Dean Mark McBeth, and Director of Development Heidi Jarvis-Grimes decided to launch the iPP after consultation with faculty members over an emerging interest in mobile technology in the classroom nationwide. The college would purchase iPads, invite instructors to apply to use them, and then furnish each student with an iPad for classroom use.

Planning the iPP

This project was designed as a collaborative effort between college administrators and faculty. Like any experiment, literature was reviewed both before and during the experiment and was used to guide the development, implementation, and evaluation of the iPP. One element of the iPP that was informed by literature was the creation of faculty learning communities (Cox, 2003). The idea of faculty learning communities lead the iPP to avoid any temptation to define exactly how the mobile technology would be used before it was purchased.

Second, the iPP considered many valid concerns found in teaching journals and more general literature about inviting (more) technology into the classroom. Nationwide, faculty views of technology and learning are mixed. Some critics see technology as a tool that is replacing faculty expertise in the classroom (Bromwich, 2014; Kolowich, 2013) and larger societal critics see technology as replacing and harming human interactions (Postman, 1993: Ritzer, 2011). Proponents like Cathy Davidson (2011), however, see technology opening a new frontier of student-instructor collaborations and she sees the technology as only improving (not harming) student and faculty interactions. Thus, the iPP hoped to explore and wrestle with the question of whether technology encourages or hinders student learning.

Third, the iPP also embraced the five principles proposed by Doering (2007). Using Doering's (2007, p. 2) words, there must be an "obvious pedagogical need;" otherwise, the use of such technology will appear gimmicky. Next, Doering argues that the use of mobile learning must be based on a pedagogical approach that is grounded in both the theory and practice of teaching. Additionally, the technology should be inexpensive for users. Finally, Doering argues that mobile learning technology should be easy to use and free from technical errors and that the use of mobile technology ultimately should be "empirically proven by monitoring and evaluation studies" (Doering, 2007, p. 2).

Finally, the iPP based some of their evaluation on work by Diemer and colleagues (2012) in evaluating the iPP. The authors of this study measured student comfort levels, student preferences for e-learning, and perceived engagement. The study found that nearly 85% of students were comfortable with the devices, 85% had at least a moderate preference for e-learning, and that there was a moderate correlation between engagement and levels of learning (Diemer, et al. 2012, 18-21).

Methods

The iPP was developed to allow the instructors to push the boundaries of their pedagogy by handing them a new tool that has the potential to enhance pedagogy. The goal was to test this concept as widely as possible. iPP administrators selected undergraduate and graduate courses as well as content and methods courses. In the first semester of the project (fall 2013), iPP administrators selected seven instructors representing a range of disciplines to participate in the program: art, history, composition, anthropology, public administration and policy analysis (political science). Another four faculty members joined in spring 2014. Project participants met regularly in person and through the online message board to collaborate and assist each other to experiment with ways to use mobile technology in the classroom.

Since the iPP was built from the ground up, determining how to evaluate the program proved challenging. The iPP leadership group eventually settled on four faculty members that would share their experiences with the iPP in the form of case studies. The case studies of four faculty members represent a sample of the faculty members who taught in the first year of the iPP. The case studies included in this study were from faculty in History, Art, English, and Political Science. The goal of the case studies was to highlight common pedagogical challenges raised in the project and discuss how faculty met these challenges.

In order to measure student perceptions, a survey was designed based on initial project goals and feedback from the midterm meeting. The survey was placed on SurveyMonkey, and a link was sent to faculty for distribution to students at the end of the fall 2013 semester. The survey was also administered in the spring of 2014. One hundred and eighteen students that had enrolled in an iPP class completed the survey during the 2013-2014 school year. The students reported their agreement or disagreement with statements related to the courses as well as statements about their own technological preparation, and the role of technology in society. The survey answered four research questions:

Research Question #1: What were student perceptions of the iPP?
Research Question #2: What were the different ways, according to students, that the iPads were used in the classroom?
Research Question #3: Were there differences in perceptions of the iPP between technologically savvy students and less technologically sophisticated students?
Research Question #4: Were there difference in perceptions of the iPP between Humanities/Fine Arts courses and Social Science courses?

While the case studies and survey helped us address the four research questions, the iPP additionally had faculty submit comments in writing at both the midterm and final meetings of the fall 2013 semester. Some of these comments are included in the results section in order to provide more context to the data. Students also could submit comments in the student survey and some of these comments are also included.

In the future, the iPP leadership group plans to continue to compile data that will contribute insights to long-term research questions regarding whether iPads in the classroom can increase enrollment, improve retention, build career-based skills, and improve learning among both undergraduates and graduate students.

Case Studies: Pedagogical Challenges

This section of the paper describes the pedagogical challenges that were faced by faculty members in the iPP and how four faculty members addressed these challenges. Four of our instructors and co-authors submitted case studies from the arts, humanities, and social sciences.

Pedagogical Challenge: How do we prepare our students to enter a digitally enhanced workplace?

Students' future employers expect that college graduates will be critical thinkers with excellent communication skills (Berrett, 2013). In today's world, however, students are also expected to be digitally fluent (Pannapacker, 2013). While Idaho State University has traditional students arriving straight out of high school, we also have non-traditional students who come back to school after realizing that they are unprepared for the job market. Our students have a range of technological skills which are determined as much by socioeconomics as age. As Instructor Brumfield found in her English composition courses, younger students tend to be more tech savvy than older ones, but age is not the only factor. There were older students who could run a small computer lab from their backpacks and back pockets, while some of her young students turned in essays that they struggled to write on WordPad as evidenced by the excruciating lack of spell check.

Nearly all of our students use technology for their personal use, but poverty and rural location both limit how much some of our students have access to the basic programs of the work force like word processing. It is a vicious cycle. Those with the least exposure to technology at home often have the weakest writing skills. They are at a significant disadvantage in the collegiate system, and they are in desperate trouble in the professional world.

All of our graduates need to be comfortable using technology, know its capabilities and limitations, and, perhaps most importantly for this digital generation, know when to set it aside. College must prepare them to represent themselves articulately both in person and the digital world. Our classrooms can help our students to question technology, pushing them to see how it can build a professional network as fast as a social one or how to use an existing technology in a new way. With the use of mobile technology, we can help them apply their critical thinking skills to their digital worlds.

In a study conducted by the Association of American Colleges and Universities (Humprehys and Kelly, 2014) 4 out 5 employers agreed that students should have a broad knowledge in the liberal arts and sciences. Further, 93 percent of employers agreed that the ability to think critically, communicate clearly, and solve complex problems was more important than a student's chosen major. Finally, employers indicated that they wanted to hire individuals who have knowledge that is specific to their field but also broad enough to collaborate with many different disciplines or fields.

To that end, the iPP faculty participants developed new ways to introduce technology and critical information skills into their classrooms. For example, [Instructor Brumfield] uses mobile devices to show her composition students what digital writing tools are available to help them write, research, cite, and collaborate online. In particular, she found that many of her freshmen struggled to know how to take notes in lecture. So, [Instructor Brumfield] creates a collaborative Google doc for each class period and then takes breaks within the lectures for everyone to do some collaborative note taking. Students can practice formalizing their thoughts, see what their colleagues caught that they missed, and interact with each other about the content that they gathered. Students collaborate on content while they either gather or share their technological experience. Everyone has access to a deeply developed page of notes to study after they leave class. Equally importantly, Instructor Brumfield can see in real time what information was gathered and what obviously needs to be covered in more depth.

Pedagogical Challenge: How do I engage students with multiple learning styles?

In learning theory, students learn in different ways. Some students learn best in noisy environments; others need quiet. Some learn best in formal classroom settings structured around lecture lessons while others thrive in informal classrooms filled with vigorous debate. Students learning styles can be auditory, visual, and kinesthetic (for a longer review of learning styles see Denig, 2004). Effective instructors use a wide mix of learning experiences to engage each kind of student.

Professor Youngs used a variety of iPad activities in an upper division environmental history course. One of Professor Youngs's course goals was to explore mobile learning technology boundaries using a situated, or place-based, learning approach. Students used iPads both in and out of the classroom to complete an original archival and field-based research project that blended the method of repeat photography with cultural geography and environmental history approaches, and extended traditional research boundaries through collaborative and social media technology.

The repeat photography exercise with the iPads presented multiple approaches to active learning and problem solving. Students related their experiences for each campus or downtown session through short, written entries in a class blog as their digital field journals. After each field day, Professor Youngs held a debriefing session by displaying the class blog on the classroom projection screen and encouraging students to exchange ideas and techniques they posted in the blog and explored during the field sessions. The exercise connected in and out-of-class activities and reinforced class concepts through repetition and review of materials in different contexts. Students quickly used this in-class activity time to reflect on their blog comments, discuss technical issues with their iPads, peer review other students' comments, and help each other to solve the challenges of capturing accurate repeat photography while describing historic landscape changes.

The iPads served as useful tools to engage students with multiple learning styles including text, visual, and oral communication using a variety of apps, digital resources, visual multimedia presentations, and hands-on learning techniques. Students gained valuable technology skills for job preparation, improved their research abilities, explored collaborative learning strategies, and learned course content in a variety of contexts.

Pedagogical Challenge: How do we make the classroom more like the real world?

Leamnson (1999, p. 39) suggests that increasingly students find college courses as disconnected from real-world problems and view higher education as a "contrived and artificial system." With this cynical view, higher education becomes nothing more than a game played by students. Students take tests, write papers, but see little connection between what they are doing and the "real world" that they inhabit. Leamnson (1999, p. 39) writes, "[s]tudents are quite prepared to play a game by any rules we lay down, but they do not take readily to mixing up 'school facts' and their real beliefs."

Ironically, the traditional classroom reinforces this dynamic in many ways. While our goal is to push students to think critically and to offer unique solutions to the world's problems, some instructors tend to do this by offering a set of concrete materials to master. Instructors select the reading and lecture materials as well as the ways that our students are evaluated on those materials. Indeed, students study us at least as much as they study our material, looking for clues about how they will be evaluated. It is a strategy that has served them well in their education and employment up to this point. Many of our students hold jobs where they are expected to perform assigned tasks, not to question how those tasks are done. They may assume that success inside and outside the classroom will be measured by how precisely they can regurgitate required materials to show that they reached the exact same conclusion as their instructor or employer, as it has been up to this point.

Professor Youngs engaged her students in a variety of learning styles using iPads. Professor Youngs's research expertise lies in digital technologies and many of Professor Youngs's classes are focused on teaching students how to use geospatial and digital technologies. In class, she modeled a peer-review method by showing the students historic and contemporary repeat photograph sets from their published or ongoing repeat photography research projects. Professor Youngs then encouraged the students to review her photo sets and discuss the accuracy, historical context, and challenges of using this method. Students used the iPads to explore online, digital photography collections hosted by museums and local historical associations that featured historical images of campus and downtown Pocatello. On field days, students used their photo evaluation skills practiced in the classroom to teach each other in their "backyards" on campus and at various locations in downtown. Students visited field site locations on campus and downtown where they created their own photo sets, compared them to their peers' imagery, and sought advice from their fellow students about their photos' accuracy and the historical landscape change.

Students used the iPads to connect course content with real-world applications and innovative technologies. The iPads allowed students to have hands-on experience in environments outside of the typical classroom setting. Through this process, they gained valuable technology skills in preparation for a variety of jobs in digital fields, improved their research abilities, explored collaborative learning strategies, and learned course content in a multiple of real-world contexts.

While there is foundational knowledge that simply must be learned, real world solutions to complex problems are rarely found by seeking out the answers of one expert. We usually stumble upon problems, reach out to widely varying sources, and integrate the results, often as a team (e.g., Surowiecki, 2005). Employers expect that college graduates are critical thinkers who can collaborate to solve the problem of their industries.

In the art studio, for example, the iPad creates a space for students to organize, save, and have their own "digital" space. Professor Ahola-Young creates an environment where students are using the iPad to organize their portfolio. This portfolio is an absolute necessity for students in a digital age. Having a digital archive allows the public, potential galleries and design companies direct access to an artist's work. Like David Burns (2010) expressed, "Historically, space and capital limitations restricted the public's accessibility to artwork, but the growth of mass digital reproduction and alternative forms of art exhibition space is having a profound effect on the valuation of digital media arts work."

With the iPad, students become active members, citizens even, of the digital (global) community. Students are able to travel the contemporary art world and find artists they relate to.

Professor Ahola-Young further encourages students to engage with the larger art community through the iPad by researching images and contemporary artists while in the studio classroom.

Pedagogical Challenge: I am an expert in X, not technology. What/how could I possibly teach with it?

Some faculty members dread introducing more technology in their classroom because our disciplines do not focus on technology as part of our learning materials. Some of us may feel like we are ill equipped to teach with technology, and that instruction is best left to more specialized instructors. Many of our disciplines are not (at least not yet) focused on the integration of electronic materials into our course content. Particularly in the liberal arts, we may focus a great deal of our time on interpersonal communication. We design spirited debate and critical thinking exercises that engage students with each other and their instructors. There is an expectation that instructors will be experts in the materials that they present. Essentially, this means that our debates with students are largely rhetorical. These debates aim instead to check the students' understanding rather than expanding our own. Integrating technology can unsettle this expectation by encouraging and sometimes forcing us to ask open questions with unknown answers.

This goes against convention. Traditionally, classroom college teaching focused on lecturing as the major pedagogical tool of the college teacher (i.e., the "sage on the stage"). While lecturing continues to play an important role in the college classroom, the exclusive use of lecturing has fallen out of favor in academic circles as studies in learning theory (e.g., Ambrose et al., 2010; Leamnson, 2009) have led many faculty to use a more dynamic, student-centered, and mixed-methods approaches in the classroom. This new pedagogical model showcases the faculty member as not only a content expert but also a facilitator of learning. Importantly, in this model of teaching, the shift in focus in the classroom moves from the professor to the students and specifically the students' learning. This is sometimes referred to as "flipping the classroom" (Brame 2013; Davidson, 2011, Mangan, 2013; Potter, 2013). Rajasingham (2011, p. 5) argues in this regard that mobile learning can "provide the bridge for communications and interactions between learner, teacher, knowledge, and problem as a collaborative process, in synchronous (real-time) systems."

When Instructor Brumfield first learned that she would have access to mobile technology in her English 1101 course, her first thought was "Those could be so helpful" and her second thought was "This is bound to go badly for awhile." While Instructor Brumfield likes technology, she has not the slightest doubt that many of her students use technology far more efficiently and creatively than she does. Her primary worry was that she would waste valuable class time struggling with technology and that the course content would suffer, taking her credibility along with it.

Though doubts loomed, Professor Brumfield took this risk because professional writing has expanded far past simple word processing. We know earlier that Professor B used a collaborative Google docs. In fact, many documents are developed collaboratively and disseminated through a multitude of platforms. While she knows well how the arguments and mechanical skills need to be developed, she thought it entirely possible that her students will have a wider range of ideas about how to collaborate during the writing process and how to disseminate the finished products. [Instructor B]'s goal was ask to questions that allowed for very open pathways to find answers, in the hopes of expanding her own knowledge along with her students.

Pedagogical Challenge: How do we get our students to think critically and push beyond their first predictable response to a question?

Particularly in the humanities and social sciences, there has been much discussion about retooling education to better connect graduates to workplace needs without sacrificing intellectual quality (Berrett, 2012; Jenkins, 2011; Pannapacker, 2013; Potter 2013). The liberal arts already excel at teaching our students how to see problems from a variety of angles, how to formulate the right questions, and how to seek answers in unconventional places. Employers seek out our graduates because they are curious and creative, write clearly, research well, learn quickly, and have excellent critical thinking skills (Pannapacker, 2013). We wanted to see where technology could help push students to ask rigorous research questions so that they could find innovative answers—first in a classroom and later in a career.

Professor Ahola-Young designs her art classes so that her art students not only think critically, but also see critically. Students often rely on cliché imagery when faced with the proverbial "blank canvas." Using the iPad to access additional information (e.g., images) opens up various possibilities for students to push past what previously had seen like obvious "solutions." Drawing requires considerable stillness and contemplation, art is a visual language and to communicate effectively means to design well. With the iPad in hand**,** students are able to evaluate image possibilities before ever touching pencil to paper. Students demonstrate less anxiety and frustration when able to play with the camera and drawing apps (e.g., Sketchbook express) then they typically do when using only paper. All art students, even professional artists, realize that an artworks meaning (for both the maker and the viewer) is open, can change over time, and is interpreted in many ways. As Lambert (2006) argues, "In art production, students seek solutions for how to convey meaning with visual imagery; and in critiquing art they seek answers on interpreting the work of others. Neither type of inquiry is clear or straightforward" (216). As artists, we have no control over this process but are constantly deeply engaged within it through dialogue, active looking, critiques, revisions, and questioning. Because works of art have multiple meanings, these investigations by students inevitably lead to critical thinking. Research shows that learning in the arts is largely inquiry based and that "A consensus of findings in research on education and critical thinking indicates that an inquiry based curriculum positively influences gains in critical thinking" (Lambert, 2006, p. 216). Art Educators purposely create assignments that are open ended and ambiguous. As Steve Jobs said, "Creativity is just connecting things" (Wolf, 1999). The iPad, and apps for drawing, allow students to merge, connect, and layer images while maintaining the integrity of originals.

Pedagogical Challenge: How do I see what my students have grasped and what needs more clarification?

Students learn best through active learning and problem solving (Edens, 2000; Smith et al., 2005). Problem-based learning is student-centered, uses group work, changes the role of the professor to one of a facilitator, presents problems to be solved, and creates a drive for self-learning in the student (Smith et al., 2000). According to Smith et al. (2005, pp. 8-9) a problem-solving approach to teaching promotes “positive interdependence” among students, “face to face” interactions between students and the professor, student responsibility, teamwork, and “group processing.” Typically, such active learning deemphasizes the lecture in favor of cases, student simulations, role-playing, and other pedagogical methods (Leamnson, 1999, pp. 83-117).

A major challenge to problem-based learning (and indeed teaching as a whole) is to determine what a student has learned from it and where they still struggle. As Angelo and Cross (1993) argue, “students need to receive appropriate and focused feedback early and often” so that they can “assess their own learning” (9). While classroom assessment techniques (CATs) have been used for many years, the traditional classroom makes it difficult to offer immediate and personalized feedback. Often, the only personalized feedback a student receives from some instructors is on the test or essay she/he has already completed, which is far too late to help her/him learn. Some faculty wish we could peer inside our students’ minds to see what they understand and where they need clarification.

Technology can get us closer to fulfilling that wish. For example, Instructor Brumfield was deeply frustrated by her composition students’ prolific and repetitive grammar errors. More specifically, she was deeply frustrated by her inability to stop them. Because she only got to interact with a student’s individual writing a few times a semester, there was little opportunity to see their problems and few effective ways to fix them. With the iPads in hand, she searched for ways that technology could let her interact with each of her students’ writing in real time so that she could see the problems in development, where her lessons were failing to connect, and how to build those lessons differently to get a better, deeper understanding. She used programs like LectureTools and Socrative to do real time writing practice. Every student could submit an answer anonymously, their answers were gathered and displayed instantly, and every text could be discussed as a group without anyone feeling singled out for their mistakes. Indeed, most of the time, students could see that everyone made mistakes and that mistakes weren’t fatal. Mistakes were even helpful since it allowed them to critically analyze what went wrong and how to make it right.

Equally importantly, Instructor Brumfield could see that she was presenting far too much information in one step. By watching her students struggle and carefully studying the pattern of mistakes, she could see that it takes a sophisticated series of semantic diagnoses to correctly place even a simple comma, which isn’t the slightest bit simple to a novice writer. By having access to this level of feedback, she renovated her entire series of lessons to include more elementary information, much smaller steps, and clearer diagnostic markers to help her students see the logic behind their choices.

Pedagogical Challenge: Can mobile technology promote better classroom discussion and classroom interaction?

Some scholars have voiced a concern that technology, specifically social media and other communication platforms, are producing a society where we, as Turkle (2010) explains in the title of her book, are “alone together.” The concern is that interpersonal relationships are lost in technologically mediated interactions (Bromwich 2014). Some faculty participants in the iPP worried that the use of iPads in the classroom would harm the vital interpersonal communication and discussion that occurs in a face-to-face classroom. Not only is such communication and discussion valued by faculty, but interpersonal communication is a key attribute of what the humanities and social sciences contribute to a student's intellectual growth. Yet, it is possible to find ways to retain and even enhance interpersonal communication with technology (e.g., Baym, 2010).

Professor McBeth was leery about introducing iPads into his upper-division and graduate level public policy analysis course. He specifically designs his course to have very active exchanges between his students and him, and he was justifiably worried that the iPads would break that dynamic. He slowly introduced small experiments into each three-hour class and carefully watched to see how the dynamics of the class shifted. For example, he started posting questions to the class blog and had students respond to the questions as the class progressed. Those blog posts intensified the discussion, brought in a much wider range of student comments, and allowed all the students, especially his quieter ones, room to expand on their thoughts so that they could be more confident in jumping into the fray of discussion.

Encouraged by that success, Professor McBeth instituted the use of pre- and post-tests. He created simple surveys about the class's material, posted the link, and received the results in real time. The students could actually see their individual and collective knowledge development change based on a night's worth of discussion. Altogether, he found that using the iPads strengthened the instructor/student dynamic, improved the students' relationships with each other, and showed the value of attending class and participating in the discussion rather than simply trying to glean information from a textbook.

Quantitative Analysis of Student Perceptions

Research Question #1: Student Perceptions of the iPP

In Table 1, the data demonstrates that students were favorable to the mobile technology as a learning tool. Students were asked to rate their agreement or disagreement with each statement on a seven point scale. The questions were then collapsed into three categories for reporting purposes. Seventy-two percent of students understood the purpose of the iPads; 67% believed that the tool would assist them in their future careers; and 63% agreed that the iPads played an important role in critical thinking and collaboration in the classroom. The iPads also received significant support as a tool for student learning (58% agreed), enhancing participation (57%), and increasing student engagement (56%). Fifty-two percent of students agreed that they wanted to take another class that uses mobile technology. One student noted in the comments section of the survey that "I saw a huge value in using the touch pads for multiple reasons and would strongly agree that this is a step in the right direction for teaching."

Table 1 Student Perceptions of the iPad

Statement	Agree	Neutral	Disagree
Student learning	65 (58%)	27 (24%)	21 (18%)
Critical thinking	73 (63%)	18 (16%)	24 (21%)
Collaboration	72 (63%)	21 (18%)	21 (19%)
Student engagement	64 (56%)	20 (18%)	30 (26%)
Participation	66 (57%)	24 (21%)	26 (22%)
Another class	60 (52%)	28 (24%)	28 (24%)
Assist in career	78 (67%)	21 (18%)	17 (15%)
Understood purpose	83 (72%)	15 (13%)	18 (15%)
Distracting	41 (36%)	25 (22%)	48 (42%)
Technology savvy	84 (72%)	14 (12%)	18 (16%)
Tech good	63 (55%)	33 (29%)	19 (16%)
Training	52 (44%)	17 (15%)	48 (41%)

Still referring to Table 1, 72% of students agreed that they were technologically savvy; 55% of students agreed that overall technology is good for society; and 44% of students agreed they need more training. Interestingly, thirty-six percent of students felt that the iPads were distracting in the classroom. This latter finding is related to the need for more training as some faculty in the project noted initial difficulties in helping students use the technology in the classroom. Additionally, some students did not understand why the iPads were being used in the classroom. One student noted in the survey comment section that "I think it was unnecessary, because students use mobile devices primarily for personal reasons, not for classroom use."

Table 2 Student Perceptions of iPad Use, Purpose and Pedagogy

Use	Count	%
Hands on application, solving problems, blogging	70/118	59%
Peer review/collaboration	52/118	45%
Discovery (exploring concepts)	79/118	67%
Solve puzzles	13/118	11%
Developing skills	54/118	46%
Multiple learning styles	60/118	51%
Assessment/testing	36/118	31%
Multimedia	70/118	59%
Critical discussion	33/118	28%
Portfolio building	32/118	27%
Data collection	65/118	55%

Note. Questions asked only in spring 2014: taking surveys/polls (21/49, 43%); research content areas (32/49, 65%)

Research Question #2: Student Perceptions of Uses of the iPads

Table 2 provides a student report of how they believed faculty used the iPads in the classroom. The most popular perceived uses were discovery (i.e., exploring concepts), hands on applications, multimedia presentations, data collection, and activities that appeal to multiple learning styles. Based on feedback from participating faculty, a new category was added for spring 2014, researching a content area, and 65% of students agreed that faculty used the iPads for that purpose.

Table 3 Technologically Savvy v. Technologically Unsophisticated Students

Statement	Fall 2013 Mean	SD	n	Spring 2014 Mean	SD	n
Tool for learning						
Savvy students	4.88	1.90	49	4.50**	1.00	34
Unsophisticated	3.75	1.49	12	2.17	1.60	6
More Training						
Savvy students	3.08**	1.91	49	2.32	2.21	34
Unsophisticated	4.78	1.98	12	3.00	1.41	6
Assist in Career						
Savvy students	5.40**	1.53	49	4.91**	1.41	34
Unsophisticated	4.17	1.80	12	2.17	2.32	6
Understood Purpose						
Savvy students	5.56**	1.31	49	4.94*	1.70	34
Unsophisticated	4.00	2.00	12	3.33	2.07	6

Note. * $p < .05$; ** $p < .01$ (unpaired t-test)
Note. Students that self-identified as neutral in terms of technological savvy were not included in this analysis. Counter to our expectations, there was no association between age and technological savviness. The scale for the statements was 0 (strongly disagree) to 6 (strongly agree). Only statements that had significant differences were included in the table.

Research Question #3: Differences between Students and Technological Preparation

Table 3 summarizes differences between technologically savvy self-identified students and technologically unsophisticated self-identified students by semester. Between the fall and spring semesters, less technologically sophisticated students were consistently less inclined to see the iPads as an important learning tool, less inclined to understand the purpose of the iPP, and less inclined to believe that the iPP would help their careers. Less technologically sophisticated students also believed that they needed more training.

Research Question #4: Were there difference in perceptions of the iPP between Humanities/Fine Arts courses and Social Science courses?

Table 4 provides information on differences between faculty from the Humanities/Fine Arts and Social Sciences. Importantly, there were no significant differences between student evaluations of the iPP between the Humanities/Fine Arts and Social Sciences.

Table 4 Humanities and Social Science Comparisons on Core Statements

Statement	Fall 2013 Mean	SD	n	Spring 2014 Mean	SD	n
Tool for learning						
Humanities/Fine Arts	3.50	1.74	30	4.62	1.80	13
Social Sciences	3.84	1.94	37	3.79	1.77	34
Critical thinking						
Humanities/Fine Arts	3.97	1.67	30	3.92	2.10	13
Social Sciences	4.05	1.72	37	3.49	1.92	34
Collaboration						
Humanities/Fine Arts	4.00	1.69	30	4.08	1.44	13
Social Sciences	3.89	1.87	38	3.77	1.75	34
Engagement						
Humanities/Fine Arts	3.83	1.78	30	3.23	2.13	13
Social Sciences	3.76	1.82	38	3.43	1.87	34
Enhances participation						
Humanities/Fine Arts	4.07	1.51	30	3.46	1.71	13
Social Sciences	4.08	1.57	36	3.23	1.82	34
Assist in career						
Humanities/Fine Arts	3.97	1.61	30	4.31	1.75	13
Social Sciences	4.39	1.62	38	4.17	1.84	34

Note. None of the differences between the Humanities/Fine Arts and Social Sciences were significant at the .05 level, in a two-tailed, t-test.

Discussion and Conclusion

Faculty participants were generally pleased with the evaluations of students. Yet, it should be noted that there were a consistent 15 to 26 percent of students that self-reported that they did not benefit from the iPP. This negative finding might be explained partially by the rural and non-traditional nature of the student body at the university. A significant percentage of students at the university are older (average age of the student body is 28) and from rural areas where technology is still distant from the student's daily lives. In this group, even technologically sophisticated students can fail to see the importance of technology in their career futures. Also note that 55% of students (see Table 1) agreed that technology was overall good for society (with 29% neutral and 16% disagreeing). The fact that only 55% of students thought that technology is overall good for society is not necessarily a negative finding and instead the finding reflects the often critical stance that some faculty took toward technology in the classroom. Most faculty members reported in the learning community meetings that there were honest discussions in their classrooms about how technology impacts social interactions inside and outside of the classroom and these discussions were not always positive. A faculty member submitted a comment during the fall 2013 midterm learning community meeting that "students had some concerns about the use of technology and social media in the classroom including ethical concerns about labor practices and concerns about social media use in general."

The next step for the iPP will be to use controlled experiments with pre and post-tests comparing student experiences in an iPP course with student experiences in a non-iPP course. This initial survey data was invaluable in moving faculty toward that goal as it has identified (for one of the first times) how students view mobile learning.

The iPP provided several significant findings in regard to mobile technology use in the classroom. First, our data is consistent with and adds to the findings of Diemer, et al. (2012). For example, their data like our data, found that most students were comfortable using the iPads, that students had a preference for e-learning, and students felt that they both learned and were engaged using the iPads.

Second, we found that the basic principle of the iPP, that mobile technology use should be driven from the grassroots by faculty experiences was well supported. Our instructors discovered discipline-specific ways to utilize technology within their own classroom. By leaving the experiment open, the instructors had an unbounded creative space to do what we demand of our students: critically think our way through the existing problems to find novel solutions. Theory and research informed this project, but much of the success required simple trial and error with faculty and students in classroom experiences. Our preceding list of questions represents the many successes of the iPP. We could present an equally long list of lesson plans that went awry, wireless networks that vanished, Bluetooth connections that were dropped, and a myriad of other problems. This is an experiment, and like all experiments, we learned from both our failures and our successes.

Third, while some faculty are concerned about technology replacing faculty expertise in the classroom (Kolwich, 2013), we found that our case studies reaffirm the essential value of faculty expertise. We agree with Doering (2007) that the use of mobile technology must fit a specific pedagogical need and that its use must be evaluated and tested. It cannot be stressed enough that technology—whether it is an iPad or pad of paper and pencil—does not teach. It is simply a tool. Our instructors' depth of knowledge, teaching experience, and creativity were central to the success of this project. Some of our instructors faced recurring pedagogical frustrations and were driven to find new ways to overcome the student learning impediments of their fields. The iPP provided a new tool to help instructors overcome those impediments.

Fourth, we found that it is possible to intersect technology with the current reinvention of the liberal arts. Based upon the data presented in this study and the ongoing discussion about the importance of liberal arts education from the perspective of employers (e.g., Berrett, 2012), we conclude that mobile technologies, such as the iPad, can facilitate the development of skills that are in high demand in our society and that prepare students not just for jobs but careers that can better withstand fluctuations in the economy.

Finally, one of the goals of the project was to determine the role of technology in the liberal arts and the better connection of the liberal arts to employer needs. We did not take this challenge lightly. There is an immediate need for graduates with strong critical thinking skills, cultural competency, clear communication skills, creative problem-solving skills, career-related skills (including technology skills), and the ability to collaborate. The iPP demonstrated that there does not necessarily have to be a dichotomy between the liberal arts and technology. Instead, technology can be used in a way that facilitates excellence in teaching and learning while also retaining the core strengths of a liberal arts education (and prepares students for careers rather than jobs).

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Appendix

Appendix 1: Survey Questions

The purpose of this survey is to evaluate the use of mobile technology in the classroom using iPads. Your professor and the College of Arts and Letters will use the information from this survey to continue to improve mobile technology use in the classroom. The data from this survey will be used in a report written by the College of Arts and Letters assessing the use of iPads in the classroom. Your response is anonymous and the data will be aggregated into a report. Your participation is voluntary.

Please rate your agreement or disagreement with the following statements (use the following scale: 0 = strongly disagree to 6 = strongly agree).

Please rate your agreement or disagreement with the following statements (use the following scale: 0 = strongly disagree to 6 = strongly agree). I think that mobile technology is an important tool for helping students learn. 0

a. I think that mobile technology is an important tool for helping students learn.
b. Mobile technology provided additional opportunities for critical thinking (analyzing, synthesizing, evaluation of information) in this course.
c. I consider myself technologically savvy.

d. I like to learn from other students and not just the professor and mobile technology provides an opportunity for student-to-student collaboration and group work.
e. Mobile technology in this class increased student engagement.
f. The use of mobile technology in face to face classes unnecessarily distracts from the learning environment.
g. Mobile technology enhances participation in a traditional classroom setting.
h. Mobile technology (like technology in general) is, overall, good for society.
i. I need more training on how to use mobile technology.
j. I am interested in taking courses that use mobile technology.
k. I see where using mobile technology in the classroom could assist me down in the road in my career or future career.
l. I understood the purpose for using mobile technology in this class.

Please indicate (by putting a check mark next to a category) whether how mobile technology was used in the class (choose as many as you think might apply):
___Using mobile technology for hands on application (solving a problem, blogging, etc.)
___Using mobile technology for peer review/collaboration
___Discovery (using mobile technology to explore different concepts in class)
___Using mobile technology to solve puzzles
___Developing skills using mobile technology
___Using mobile technology to emphasize multiple learning styles
___Using mobile technology for assessment/mobile testing
___Using mobile technology for multimedia
___Using mobile technology for a critical discussion of technology
___Using mobile technology for portfolio building
___Using mobile technology for data collection
___Using mobile technology to take surveys or polls in class
___Using mobile technology to research content areas

Demographic questions are excluded from this appendix.

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Using NetLogo as a Tool to Encourage Scientific Thinking Across Disciplines

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Abstract

Abstract: In this article we discuss the possible uses of NetLogo as an educational tool for High School and early-years undergraduate students. The paper is geared towards teachers from all disciplines who require students to problem solve, be quantitative and logical but want a project orientated platform to build or reinforce knowledge. The tools and methods herein were chosen specifically to be picked up by non-computer literate users. The goal is to highlight possible ways to excite students who perceive themselves to be weak mathematically through non-traditional computer-based exercises. In essence, we wish to encourage students to understand technology so they interact via easy coding rather than solely pushing buttons on an interface. Here we choose a model of toxoplasmosis gondii to demonstrate our ideas and show how scientific thinking and mathematical modeling can be used by the wider teaching community. Although these methods could be used for any age group or scholarly level, here we build our ideas around students who have seen high school algebra and may have studied one semester of differential calculus. Finally, we give some ideas of how NetLogo could be incorporated across the curriculum. Code for each module is available for download to assist teachers (Gammack, 2015).

Keywords: interdisciplinary teaching, scientific thinking, agent-based modeling, NetLogo

Computational technology is used in all walks of life, from the abundance of “smart” phones, appliances around the house, even the humble bicycle can have electronically operated gear shifters. For the majority of these, the technology is used purely via an interface - there is no deeper understanding or modifying of the underlying code. As the world becomes more interconnected, and jobs rely on connecting ideas from different disciplines, we want our graduates of the future to be comfortable with both using the interface and being able to appreciate the capabilities of the underlying technology. While not everyone needs to be hotshot coder, it can be helpful to understand some of the issues involved. For example, a project manager, whose deliverable is an oven monitor that switches the heat off when the moisture levels fall below a certain threshold, should have a broad understanding of the individual tasks of her team members. Similarly, researchers from all disciplines use computational technology to varying degrees: pure mathematicians may only use documentation preparation software (Word, LaTex, etc.), whereas a geography PhD student may need to code GIS (geographic information systems) mapping software. To help graduates understand the importance of a deeper understanding of technology, scientific thinking and hands-on building needs to be encouraged

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throughout education at various age-group levels. Although this is a challenging proposal, the authors hope to show that engaging students with realistic projects can aid both their comfort level with technology, and also develop their subject matter knowledge.

Working in a small liberal arts college with a tiny population of mathematics majors, the authors instead work with students who want to do research from non-mathematics disciplines (Biology and Business being the main culprits). Usually, these students have had high school mathematics (algebra/trigonometry/precalulus) and may have started a college level mathematics class (calculus or statistics). A complication is picking tools that students can use so that they can make progress and have a fulfilling experience despite their lack of computational skills. The same challenges are true in other disciplines and non-undergraduate students. In our experience, the NetLogo (Wilensky, 1999) (see §2) platform serves both purposes.

Consider the following example from political science. In a given population of voters, can we determine the boundaries for voting districts that will create safe seats for the incumbent candidate? The basis of this problem is easily understandable and applicable to many students. It is also a problem that can be modeled and experimented upon using Agent-Based Models (ABM). A starting point for this project would be the voting model that can be accessed via the Models Library in NetLogo (Wilensky, 1999). A more academic look at using ABM to assess the outcome of an election between political parties can be found in Laver and Sergenti's book (Laver & Sergenti, 2011). The ABM in the NetLogo library bases preference on neighboring voting patterns (peer pressure). An interesting extension would be to consider the environment as a State and use the ABM to decide voting boundaries so that the result of the next voting cycle is biased towards the incumbent party (gerrymandering). This example highlights how a "non-math" problem can be used to hook students in and teach them modeling and reasoning skills.

Agent-Based Models (ABM) are computational descriptions of real world phenomena. The two main components to an ABM are the environment and its agents. The environment is the space in which phenomena occur: a street, a house, bodily tissue, or an abstract environment. Agents inhabit the environment: cars and people on a street, people, pets and germs in a house, cells and bacteria in tissue. To design an ABM the user needs to make assumptions about the interactions between individual agents and between the agents and their environment. These interactions could be logical (if x then y), probabilistic (there is an $x\%$ chance of y) or function-based ($y = f(x)$). Once the interactions have been coded, simulations can be run and conclusions drawn. For a full introduction on ABM, see (Railsback & Grimm, 2012).

The model presented here was developed as part of a research assignment with two biology majors. However, the authors hope that it is apparent how this model (or a new teacher-motivated model) can be developed by students from HS and up. To assist teachers using this material in the classroom, all code is available for download. Please note that code is like a modern house in a new community; there are similar structures found around a neighborhood, but no two houses are exactly alike even if it is only a difference in paint color. Be suspicious if your student's code is an exact match to the downloadable versions.

Although there are many different ABM platforms (including Mason, NetLogo, RePast, SWARM) (Nikolai & Madey, 2009a), we use NetLogo for three reasons: (1) it is free; (2) it is simple to download and run on mac or pc; and (3) although not as rich as some of the other platforms, the syntax makes it easy for non-programmers to progress quickly. For a fuller introduction to ABMs and NetLogo, please see (Gammack, Schaefer, & Ga, 2013; Laubenbacher, Jarrah, Mortveit, & Ravi, 2012).

NetLogo is an agent-based modeling tool that allows the user to specify how agents (people/cells/objects) interact with each other and their environment and to then examine how the system evolves over time. We have led student research projects using NetLogo to model a variety of natural phenomena (cholera outbreak, the development of neuronal pathways and toxoplasmosis spread) over the past 4 years and a few things have become clear: (1) non-mathematics/IT students are not afraid of NetLogo; (2) students are excited by the progress they can make in a short time; (3) it helps enforce precision of thought and develop scientific rigor. Additionally, NetLogo is a useful tool across the academic spectrum: from mathematics/IT undergraduates to students who have yet to take a college mathematics class. The goal of this paper is threefold: (1) to give a brief overview of NetLogo; (2) highlight ways in which mathematical and scientific ideas can be incorporated into the learning experience through modeling the spread of *toxoplasmosis gondii* on a pig farm; (3) demonstrate how NetLogo can be incorporated across disciplines and mathematical levels (High School through College).

For the purposes of this paper, we assume that students have taken (or are taking) high school algebra, but we also include Learning Experiences for more mathematically advanced students. In §2 we develop a NetLogo model and describe some parallel classroom exercises that can be picked up and used by anyone willing to open a new computer program; §3 gives some ideas about using NetLogo across other disciplines. In §4, we present results from student NetLogo usage and we close with §5, a brief discussion on assessing the validity of NetLogo as an educational tool.

Modeling and Learning with NetLogo

Throughout this work, we highlight the learning opportunities of NetLogo via a student-initiated project that models *toxoplasmosis gondii* on a pig farm. The tools used were intentionally chosen to welcome the widest audience. They are free, easy to use and well documented. Working examples of the custom code required are available for download to provide a guide and support. The models themselves were chosen to be relatively simplistic to allow students and teachers to focus on learning how to break a problem apart and model it. At each stage of modeling, we present a “learning experience” that can be used to develop and assess each student’s progress.

A Note about Student Driven Models

One potentially difficult aspect of modeling natural phenomena is deciding what is crucial information and what can be neglected. This can be a problem for students as they sometimes have some trouble letting go of ideas. For example, when developing a model of the spread of a disease a student might rightly argue that an individual’s age effects their immune system, which in turn plays a part in their likelihood of becoming infected. However, that aspect could be brought in later in the standard modeling “circle” (see Figure 1) when the user reassesses her assumptions and refines the model. For the purposes of this article, we consider a simple model of the spread of *toxoplasmosis gondii*. The original (more complicated!) model was developed by two undergraduate Biology students at Marymount University. We have mapped out the initial models so that it is easy for students to make initial steps towards their goals. As they progress, students should then be encouraged to refine and expand their models once the basics are grasped.

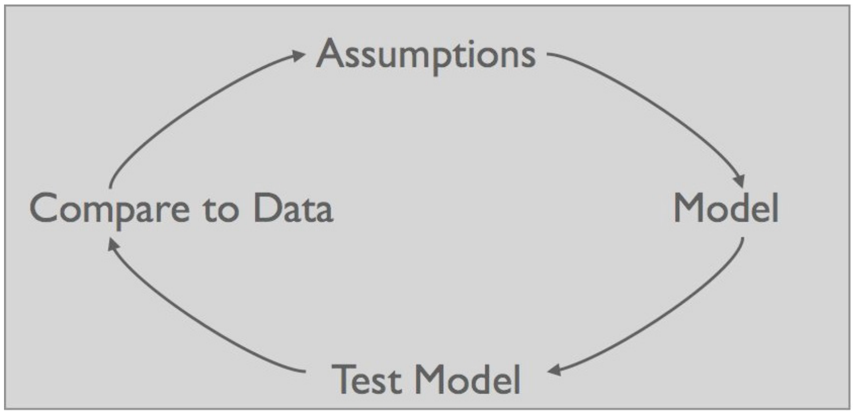

Figure 1: Model Development Cycle

Basics of NetLogo

When NetLogo is run, a blank GUI Interface appears with three main tabs at the top: *Interface*, *Information*, and *Procedures* (see Figure 2). The tabs purposes are as follows: *Interface* - where the simulations are run; *Information* - for comments on the model's assumptions and uses; *Procedures* - where the code is written. In addition, *Settings* can be used to define the overall size of the simulation window and the patch and font sizes. In the next three subsections we will introduce the basics of setting up the environment, the agents and their interactions.

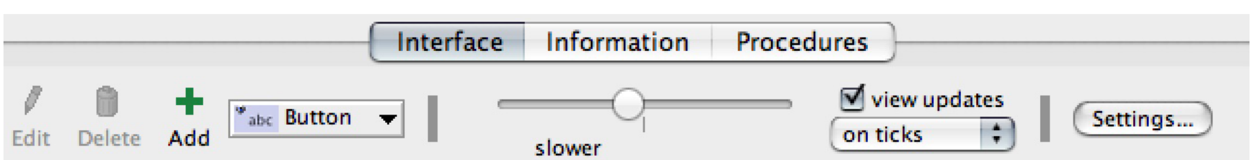

Figure 2: NetLogo Control Bar

The remainder of this paper concentrates of the building of the model (the *Procedures* part of NetLogo), but here, for completeness, we give a brief overview of the *Interface*. Figure 3 shows the NetLogo program when initially opened - note that *Interface* is highlighted, indicating that the user has arrived at the front-end (user interface). The user can add/alter three main components at this point:

- Add user interface controls. E.g. *buttons* that run all or part of the code; *sliders* that allow users to alter model parameters; on/off *switches* to allow for certain routines to be ignored or incorporated (for example, a user may be testing the hypothesis that quarantine is the only way to stop an outbreak of measles in a school). In addition, the user can define outputs to be displayed (plots, population numbers, etc.).

- Alter how the output is displayed. E.g. change the speed and/or have the simulation update the output every "tick" (the time interval being used).

- Alter environmental settings. E.g. change the dimensions of the environment, the size of each patch/agent.

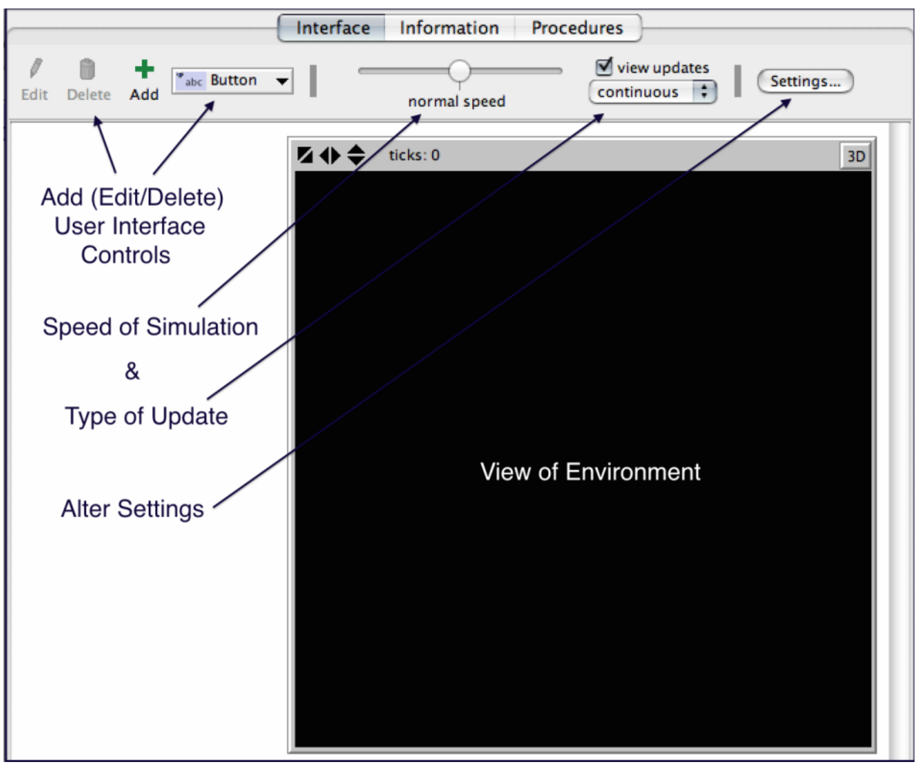

Figure 3: NetLogo Interface

Defining the Environment

The NetLogo environment is made up of discrete areas that agents move around on called *patches*: imagine if roads and sidewalks were replaced with paving slabs rather than a continuous layer of concrete. Each *patch* can have its own properties: color, dirtiness, temperature, stickiness, etc. For simplicity, we assume the farm is square, with a rectangular pig enclosure. The farm covers the whole area of the screen and the pig enclosure takes up one section of it. We color the boundary of the farm yellow and the pig enclosure brown. The code required to build the basic layout is given below. (Note that lines beginning with ;; are comments to the user.) The code can be found in NetLogo file *enviro-1* (NetLogo Models, n.d.) and in **Error! Reference source not found.**

```
to setup
      ask patches [ setup-environ ]
end
to setup-environ
      set pcolor green
      draw-walls
end
;; ***************************************
;; The above runs the set-up command followed by setup-environ
;; which sets all the patches to be green
;; and then calls the draw-boundary command
;; ***************************************
to draw-walls
      ;; draw left and right boundary of the farm
      ask patches with [abs pxcor = max-pxcor ]
      [ set pcolor yellow ]
      ;; draw top and bottom boundary of the farm
      ask patches with [abs pycor = max-pycor ]
      [ set pcolor yellow ]
      ;; boundary of pig-enclosure
      ask patches with [pxcor = 0 and pycor <= 19 and pycor > -10]
      [ set pcolor brown]
      ;; draw left and right boundary of the farm
      ask patches with [pycor = -10 and pxcor <= 0 and pxcor >= -19]
      [ set pcolor brown ]
end
```

Figure 4: NetLogo code for Farm Layout

Note that under the settings tab in NetLogo the dimensions of the environment can be set and that, in this case, the origin is at the center and both axes have dimensions (-20, 20). Also note that all code is available via download.

Now, when we click to the *Interface* tab, a button needs to be defined that will implement the "set-up" code. First, we click on "button" and an edit window opens (Figure 5). Under

"Commands" we write "setup" which is the name of the set up code (see above) and then choose a display name. Once we click "OK" there will be a button on the interface that allows us to execute that part of the code. All buttons are set up this way, and we leave it to the reader to examine the individual codes to see how other interface controls are defined. Figure 6 shows the output after the "Setup" Button has been pressed.

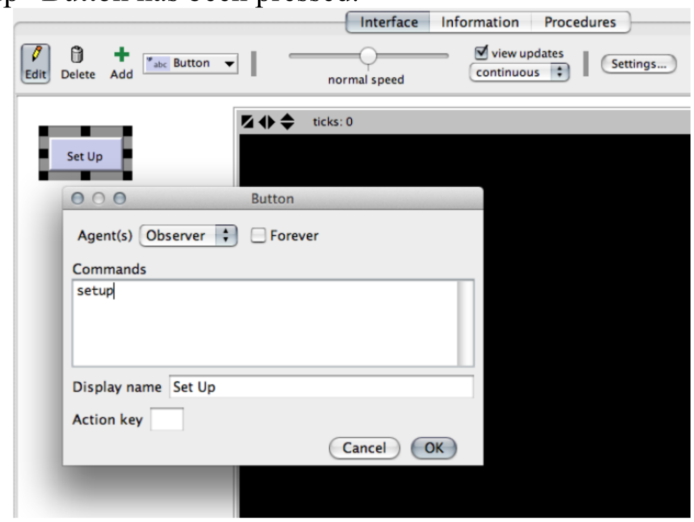

Figure 5: Creating a Setup Button

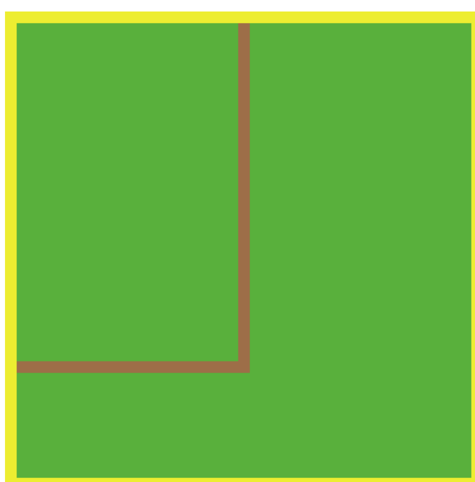

Figure 6: Farm Environment. Yellow indicates the border of the farm, brown indicates the pig enclosure and green is the environment on which the pigs move (grass/field).

Learning Experience

Although this can be thought of as purely an opportunity to develop some low-level coding skills, exercises could be brought in to engage students in relevant mathematical ideas. Ideas for questions:

Example 2.1

(a) *(Algebra) If the pig enclosure needs 100 m^2 of open land on the south (bottom) side and each pig sty is 2m $\times$ 4m how many sties could fit end-to-end in the enclosure?*

(b) *(Algebra) If each sty requires 1m of open ground around it (on all sides), how many sties could fit in the enclosure?*

(c) *(Algebra) If each sty holds 8 pigs, how many pigs can the farmer have?*

(d) *(Calculus) The farmer has 38m of fencing. What is the maximum area she can enclose for the pigs?*

(e) *(Biology/Ecology) What are the guidelines regarding healthy dimensions of pig sties? How many pigs should be allowed in each sty?*

(f) *(Business/Algebra) The initial cost of setting up the farm is \$9,500 and the cost of rearing a pig is \$400 per pig. If the farmer can sell a pig for \$450, how many pigs must she rear (and sell) before making profit?*

Defining Agents

Agents populate the NetLogo environment. Just like the environment, agents can have specific properties (color, age, level sickness, dirtiness, etc.). Additionally, agents can move about the environment, but we leave that till §2.5. Here we introduce pigs into the farm. First we need to define a *breed* called pigs, then create some pigs, and give them a shape and a place to start. The code for implementing this is as follows in Figure 7 (NetLogo file *enviro-2*). Note that the following code (and that of the remainder of the paper) is additions and modifications to the original “set-up” code introduced in §2.3.

```
breed [pigs pig] ;; defines a new label for the agent
to setup
      …
      create-pigs 20 ;; creates 20 pigs
      ask pigs [setxy random-pxcor random-pycor ;; places the pigs
      at random points in the environment
      set shape "pig"] ;; makes them pig-shaped
      …
end
```

Figure 7: NetLogo code to define Pigs.

Here, `ask pigs […]` means that all commands given between the brackets are applied to each pig. In this case, each pig is pig-shaped and is sent to a random (integer valued) *(x, y)* coordinate. Note that information on a command can be found by right clicking on the word in the procedures tab and selecting "Quick Help" or searching the help documents.

Learning Experience

At this point, when students run the model they will (hopefully) see two problems: (1) pigs are everywhere - in the enclosure, the rest of the farm, even on the boundaries of the environment, and (2) the pigs are all different colors. This leads to a simple coding exercise:

Example 2.2 *Coding*

(a) *Make all the pigs pink. Hint: what does the command* color *do?*

(b) *Make the placement of pigs be random within the pig-enclosure. Hint: this is trickier than it initially seems. First define an area called* pig-enclosure *and then use the command* move-to one-of pig-enclosure *when setting up the pig population.*

Now we need to work out how the agents interact with their environment and each other.

Defining Interactions

In NetLogo, we need to define how the environment (individual *patches*) is affected by an agent as it passes through it, and vice-versa. There are various, standard, considerations (ex. movement of agents) but rather than pick and choose random concepts, we discuss the development of a model of *toxoplasmosis gondii* spread as the motivation for developing certain interactions. This is also a great method of learning as students can decide what is necessary to include.

Toxoplasmosis Background

Toxoplasma gondii can infect any warm blooded animal, but only breed in cats (Dubey & Frenkel, 1998; Flegr & Havlicek, 1999; Fuller Torrey & Yolken, 2003; Miro, Montoya, Fisher, & Fuentes, 2008; Tenter, Heckeroth, & Weiss, 2000). *T. gondii* can alter the behavior of humans, causing them to exhibit some of the following symptoms: an increased affinity for cats, headaches, fevers, and confusion. Although, toxoplasmosis is a not a deadly disease, it is detrimental to people with autoimmune deficiencies (Jiang, Sullivan, Su, & Zhao, 2012). Research has shown that infected drivers have a six-times greater risk of traffic accidents (Flegr, Klose, Novotna, & Berenreitterova, 2009). It has also been linked to schizophrenia (Fuller Torrey & Yolken, 2003). Internationally, some countries have a 95% infected rate, with hot and humid regions having the highest prevalence (*Toxoplasmosis*, 2013). Studies have shown a rising rate of toxoplasmosis infection in farm settings. In particular, researchers have shown several cases of toxoplasmosis in pig farms in China and Brazil (Du et al., 2012; Piassa et al., 2010). Additionally Weigel et al. have highlighted risks of infection on farms in Illinois (Weigel, Dubey, Dyer, & Siegel, 1999).

Unlike the model of Jiang et al. (Jiang et al., 2012), here we consider purely the interaction between the infectious adult cats and the pigs on the farm. In this case, the pigs are not actively spreading the disease around the farm, but could contribute in infecting humans via the environment and by infecting the food chain (Kijlstra et al., 2004; Tenter et al., 2000; Weigel et al., 1999). Table 1 lists some very basic assumptions we take from the literature. The NetLogo files *enviro-3* and *enviro-4* have all the relevant code for the rest of the learning experiences up to Ex. 2.6.

Table 1: Basic cat and pig population assumptions

	Cat	Pig
Movement	Random throughout the farm	Random within pig enclosure
Disease	Spread by feces Constant levels within host	Infected by feces
Reproduction	Neglected	Neglected

Learning Experience

Example 2.3 *Coding*

(a) *Define a new breed:* cats.

(b) *Place 5 cats randomly on the farm.*

(c) *Make all the cats black.*

```
to move-pigs
      ifelse (random 2 = 0) ;; random 2 gives an answer of 0 or 1
      ;; (stay put or move)
      [
            fd 0 ;; if random = 0, pig does not move
      ]
      [ ;; if random = 1, pig moves
            set dirnum random 4 ;; pick a number 0 (fwd), 1 (bwd)
            ;; 2 (left), 3 (right)
            if (dirnum = 0) [fd 1]
            if (dirnum = 1) [fd -1]
            if (dirnum = 2) [left 90 fd 1]
            if (dirnum = 3) [right 90 fd 1]
      ]
end
```

Example 2.4 *Modeling (do not try to code these yet)*

(a) *(Probability) If the animals are moving randomly, how can we think about this in terms of probabilities? What are the chances of an animal moving left/right?*

(b) *(Biology) How can we decide when the cats will leave feces on the ground?*

(c) *(Biology/Modeling) What are we neglecting that we should not leave out?*

For pig movement we could assume that they have an equal probability of moving or staying put. If they move, the probability of each direction is the same. Therefore, the code could be:
However, pigs should not be able to run through walls!

Learning Experience

Example 2.5

(a) *(Probability) What is the probability of moving left?*

(b) *(Coding) How can you stop the pigs leaving the pig enclosure? Hint: one method is for the pigs to check the color of the patch they are going to move onto and if it is the color of a wall/boundary, do not let the pig move there.*

(c) *(Modeling) What is the model missing?*

Figure 8: NetLogo code to move pigs

With the cat population, we need to incorporate movement and defecation during the simulation. For this (and for the pig movement) timing is important. Therefore, we need to develop a way of keeping time within the simulation. First, there is a command `tick` which does exactly what it sounds like it should: it moves the simulation one "tick" (or one time unit). The following piece of code demonstrates the use of `tick`. The code in Figure 9 will now keep running *ad infinitum*. This raises a couple of questions: (1) how do we define a unit of time; and

```
to go
     ask pigs [move-pigs] ;;calls the move-pigs command
     tick ;;steps time forward one unit
end
```

(2) how do we end a simulation. Both of these are relatively straightforward exercises:
Learning Experience: Modeling/Mathematics/Coding

Example 2.6

(a) *Define mins/hours/days as global variables assuming that each* `tick` *represents 1*

Figure 9: NetLogo code to move pigs in time

minute. Hint: in setup *initialize mins/hours/days to zero and then after the* `tick` *update each variable. Note that to update hours and days you will need the* `mod` *command.*

(b) *Make the simulation end after 60 days. Hint: you will need the* `stop` *command.*

(c) *Stereotypically, cats are active, pigs are lazy! Can you make the cats move more often than pigs? (Hint: pigs do not have to move every tick.)*

At this point, students can build in the more complex parts of the natural phenomena: the spread of the infection. To start with, it is easier to get students to assume that cats defecate at set times of day and that they leave behind a set amount of toxoplasmosis. Then, when a pig moves onto an infected patch, make the pigs chance of infection be 50/50.

Learning Experience: Modeling/Coding

Example 2.7

(a) *Assume that cats defecate 4 times a day (every 6 hours), and when they do, they infect whichever patch they are currently standing on. Make an infected patch turn red. Hint:*

create an infection*? variable that the patches own that becomes* true *when a cat defecates on it.*

(b) *Make the pigs check the infection status of the patch they are on and then have a 50/50 chance of becoming infected. Make an infected pig turn black.*

At this point students will have a very basic model of a pig farm that is host to a pack of feral cats infected with toxoplasmosis. The next stage of development would be to make the model more realistic and to include various disease specific events/variables. Suggestions for extensions would be:

Learning Experience: Modeling/Coding

Example 2.8

(a) *Most diseases have a limited amount of time that they are viable outside of the host (equivalently, bacteria in feces becomes less infectious over time). What is this time for* toxoplasmosis gondii *and how could you incorporate this in the current model?*

(b) *Not all cats defecate at the same time! How can you randomize this process?*

(c) *At the moment pigs have a 50/50 chance of becoming infected? Research the infection rate for* toxoplasmosis gondii *and incorporate a more realistic probability of infection.*

Incorporation into the Classroom

There are many ways to extend the model, either towards teacher-prompted scenarios, or by letting students have free-reign. What can be useful is assigning each small group a coding "guru" who has the responsibility to have all the code commented (annotated) so that it is easy to follow, and then try to combine the best parts of the individual projects into one deliverable from the class. For example, group one (G1) could be assigned to model the environment, G2 the movement of the animals, G3 the act of defecation spread of the disease, G4 the infectious state of the host, etc. Then, as groups deliver their sections, the next task would be to combine elements (combining G1 with G2 and G3 with G4 before pulling it all together). This takes planning, but students are excited to see how their individual elements can affect the overall outcome of the simulations.

Once the basic model has been constructed, questions can be posed like "How can you eradicate the disease on the farm?", "Would culling or quarantine be preferable?"

Other Examples

We have given a brief overview of the development of a NetLogo model of *toxoplasmosis gondii* and ideas on how to engage biology students in a small research project. It should be reasonably straightforward to see how other models could be developed to excite students. How about discussing a simple cold spreading through your HS? Students can work out that there are those students who are not sick/sick/have been sick and you can work out how their interactions effect the health of the school body as a whole. Then there is the spatial effects: what happens if just one person is sick and they are quarantined? Would that stop everyone else getting sick? Then the model can be developed by the students: some can develop the geometry of the school and how that geometry and the school's timetable alters how people interact. Other students can look at how to model the passing of germs between sick students and the environment/other students.

One of the neat things about NetLogo is that it can be a useful tool across the curriculum and there are many examples, from different disciplines, in the user-generated library to be examined. For example, if you are teaching an ethics or modern history course you could introduce Schelling's Tipping Model (Schelling, 1971) which investigates the effects of behavioral choices of individuals on a community. In brief, Schelling's Tipping Model can be seen as the effects of bias on a community: the model assumes that there are two agents (let's say red and green) and an agent has a percentage bias for living in a community where a certain number of its neighbors are of the same color. Now randomly assign each agent to a specific “home”, and then let them move if they are “unhappy” (not enough red/green neighbors). The amazing thing is that segregation occurs at relatively low levels of bias: all agents could be happy with 50% of their neighbors being the other color and *still* there would be segregation. Students, to start with, could investigate this model on a chess-board and then, when they realize how large the community needs to be, investigate further via the simulation in the NetLogo library.

For a sociology project, how about studying the spread of knowledge in an environment: is it more likely that opinions/beliefs are passed peer-to-peer, or from teacher-to-student? Students can set up an environment where one person wants to be class president and that person can either campaign on issues, or could start a smear campaign. Which method works? A political science project could examine gerrymandering, as discussed in §1, or even look at how/if targeted advertising campaigns could influence an election. For a history project, students could develop a model of warfare. For example, there have been models of the Iwo Jima conflict based on Lanchester's warfare models (Lanchester, 1916; Engel, 1954). Most of the models do not contain spatial elements, so students could build the environment and then mimic the battle.

Brief Summary of Student Experiences

The authors surveyed six of eight undergraduate summer-research students who used NetLogo. Of those surveyed, 1 is a current Marymount University graduate student, the other 5 are alumni. A brief review of responses can be seen in Table 2 and Table 3.

Table 2: Basic Information about Students

School Year	Degree Major	Subject Area of	Previous	Use of NetLogo

when initiating project		Project	experience in subject area	increased subject area knowledge
Sophomore (4) Junior (1) Senior (1)	Biology (4) Mathematics (2)	Axon Guidance (2) Cholera (3) Toxoplasmosis (1)	None (6)	Yes (6) A Lot (4)

Table 3: Student's Use of Technology

Coding Experience	ABM/ NetLogo Experience	Nervous about using technology	Was NetLogo difficult	Happy to use technology in the future
Limited (4) None (2)	None (6)	Yes (4) No (2)	No (5) A little (1)	Yes (5) No (1)

Although our data points are limited to six (out of eight) students who responded to our survey, we claim that students found an increase in the subject knowledge, that they felt that NetLogo to be relatively easy to pick up, and that they would be happy to use technology in the future. However, it is important to ask if it is *useful* to use ABM, or other computer software, as a tool for learning. The authors would argue that it depends on why and how the platforms are used. For instance, the author and collaborators for the student projects had two main goals:

- to foster academic research in undergraduate students
- encourage scientific thinking

Both of the above aims were to be accomplished with students who were not necessarily interested or invested in learning about computational techniques, but who had been motivated by the idea of cross-discipline collaboration. For the purpose of this paper, the authors are highlighting the ways to encourage students to use technology in a deeper way than usual (active coding rather than relying on an interface).

However, we do want students to feel that the methods we use in teaching are useful in the classroom and beyond. For example, in (Gammack et al.,2013) a model for axon guidance is discussed. The initial development of the model was done by two biology majors (one who had yet to take calculus I). The project was intended to be a laboratory-based investigation of axon response to different guidance cues. The students realized that, due to monetary and laboratory constraints, it would be impossible to make any tangible progress with the project in the time allowed. However, with a student did note that "... for this particular project the lab work, if it had been done more extensively, would have been sufficient (sic)". A student who worked on the toxoplasmosis project noted that they could not have researched in the lab "... as the purpose of the project was to model the transmission of the disease. ... it would have been much more complicated and dangerous to test in lab (disease agent)".

Discussion

Agent-based modeling (ABM) can be an effective tool in a class setting when a project and outcomes are clearly defined, and the roles of individual groups are laid out. There are many software platforms that could be used. NetLogo has been highlighted here because of its ease of use, for non-computer programming literate students, and it is a free, cross platform package that has many user defined models loaded into its library.

Once students become confident playing with an ABM package it can become a useful tool for interdisciplinary study and can motivate students to look beyond the confines of their favored subjects. As previously stated, there are many different ABM platforms and each has their own strengths. For a full discussion, the authors suggest reading the excellent reviews by Nikolai and Madey (Nikolai & Madey, 2009b) and Railsback et al. (Railsback, Lytinen, & Jackson, 2006).

In terms of working with the software, students stated that NetLogo "...is easy to use and understand, the example scripts were extremely helpful in developing our own code. Also it was a great help to be able to just run the script and see the changes instantly to the Display (sic)". "Example scripts" in this instance refer to the library in NetLogo that has examples from art, mathematics, natural science, social science and more. All of the programs are ready to be run and, in the author's experience, students enjoy the "hacking" mentality they can employ as they start to build their own models. Another student noted that "I have gained key coding skills and it has added to my experiences. After graduating, noting that I am able to use NetLogo on my resume has helped me a lot in finding professional experiences." This is one of the author's goals: to enthuse non-IT undergraduates about the opportunities they can have by using cross-disciplinary tools.

Although we do not have enough data to statistically demonstrate the power of using ABM in the classroom, we hope that we have expressed the potential in using computational software across disciplines. The next generation of graduates need to be able to do more than just use the basic programs, they need to be able to see the potential problem solving capabilities at their fingertips and help implement those solutions.

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Revisiting Use of Real-Time Polling for Learning Transfer

Sheri Stover[1], Dan Noel[2], Mindy McNutt[3], & Sharon G. Heilmann[4]

Abstract: Instructors in five different undergraduate courses designed their courses to include real-time polling to increase their students' levels of engagement and participation in an attempt to enhance students' learning transfer. Bjork (1994) defined learning transfer as "the ability to use information after significant periods of disuse and the ability to use information to solve problems that arise in a context different (if only slightly) from the context in which the information was originally learned" (p. 187). This mixed methods research study examined the results of those efforts after surveying students' perceptions of whether the use of real-time polling had an effect on their understanding of the course content and their levels of participation and engagement in the classroom. Instructors used Poll Everywhere to incorporate real-time polling in classes where 98% of students had suitable devices to respond to the polls. Results from this survey indicate that the use of real-time polling helped students better understand the course material and also increased their level of participation and engagement.

Keywords: real-time polling, Poll Everywhere, learning transfer

Faculty members in higher education have begun to implement clickers in their classroom. Clickers are also known as *audience response systems* and *real-time polling*. Clickers are hand-held devices that students use to respond to questions displayed on a computer projector. A receiver device records students' responses and then displays the aggregated results for the entire class to see (Campt & Freeman, 2010). Most frequently, clickers are used to respond to multiple-choice questions, but some clickers allow students to type in short, open-ended responses. Clickers are sold for about $30 to $40 from manufacturers such as TurningPoint and iClicker (Kelly, 2011). These costs can place an additional financial burden on students, many of whom have reported dissatisfaction in being required to purchase a clicker and then having to remember to bring it to class (Patry, 2009).

Companies like Poll Everywhere now provide real-time polling where students can use their cell phones to respond to polls. The advantage of using cell phones is that students can use a tool that most of them have readily available (Dahlstrom, 2012). Poll Everywhere has an educational plan where instructors can utilize the polling for free in classes that have no more than 40 students. Once the polls are created, the instructor displays the questions on the computer projector for all students to see. Students can use their smart phones, feature phones, laptop computers, or tablets to respond to the real-time polls (Poll Everywhere, n.d.).

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It is not the technology that enhances students' learning; however, it is the ways in which the instructor utilizes the technology. Real-time polling is important because it is a tool that can be utilized by instructors to implement teaching methodologies into their classroom that will enhance their students' learning transfer.

Literature Review

Many college faculty members continue to teach the way they were taught, using didactic lecture with a mid-term and a final exam to assess students' learning (Halpern & Hakel, 2003). This results in students who can achieve satisfactory grades by memorizing the material to pass the test, but does not result in a large numbers of students being able to transfer their learning to future situations (Bransford, Brown, & Cocking, 2000). Instructors need to incorporate teaching methodologies that help prepare students to be independent learners, capable of applying their learning in authentic situations beyond their college classes (Halpern & Hakel, 2003). This literature review will outline the current research on learning transfer and address whether the use of real-time polling can enhance the design of a class to improve learning transfer.

Ratey (2002) defined learning as a change in the neural networks in the brain. He concluded that the brain has the ability to store information in its short-term recall; thus, students can memorize information and retrieve it for tests. However, if the information is not used again, it is purged from the brain (Ratey, 2002). Bjork (1994) defined learning transfer as "the ability to use information after significant periods of disuse and the ability to use information to solve problems that arise in a context different (if only slightly) from the context in which the information was originally learned" (p. 187). The primary mandate/undertaking of colleges and universities is to teach in order for students to be able to transfer their learning. In other words, transferring knowledge implies that students can accurately recall and use knowledge, skills, and attitudes learned in college at a later time in their career (Schwartz & Bransford, 1998). Since it is challenging to predict the types of situations in which students will be required to apply their knowledge, the aim of higher education should be to facilitate students' ability to transfer what they have learned so students can independently implement solutions (Halpern & Hakel, 2003).

Most instructors assume that learning transfer happens once students have successfully completed the class, but this does not always happen (Leimbach & Maringka, 2009). Wiggins (2012) found that students have challenges transferring the content learned in previous classes unless the classes are specifically designed for learning transfer. Classes that are designed to enhance students' learning transfer need to ensure that students have high levels of engagement and participation. Student engagement is defined as the "time, energy, and resources [that students] spend on activities designed to enhance learning" (Exeter, et al., 2010, p. 762). Student participation is defined as a "student's willingness, need, desire, and compulsion to participate in, and be successful in, the learning process" (Bomia et al., 1997, p. 3). Classes that are designed to enhance learning transfer and include high levels of student engagement and participation include the following characteristics.

Active Participation.

The first characteristic of classes designed to enhance learning transfer is that students are active participants in the learning process. Students cannot simply be passive learners who are merely exposed to information through didactic lecture and assessed at surface levels (Bransford et al., 2000). It is critical that students gain deep understanding, which requires them to spend a substantial amount of time working with the academic content. When students are repeatedly required to generate responses to real-time polling questions with minimal cues, they strengthen their neural connections. Halpern and Hakel (2003) refer to this strategy as “the single most important variable in promoting long-term retention and transfer” (p. 38). Requiring students to frequently retrieve information creates a “memory trace” and repeated practice strengthens the neural connections. Incorporating frequent real-time polling during each class moves students from being passive learners to becoming active participants by continually requiring them to “practice at retrieval” (Halpern & Hakel, 2003, p. 38).

Classes in which students are passive learners and receive information from teachers who lecture result in student memorization and ‘cramming’ in preparation for tests (Organization of Economic Cooperation and Development, 2009). Students may receive good grades because the brain’s short-term recall can store information for 18 to 36 hours (Bjork, 1994). If students do not continue to practice using that information, any new cellular material is reabsorbed by the brain and the information is not retained (Zadina, 2008). In a lecture-based classroom, the instructor is the one who is firing his or her own neuron network and the students are in a state of passivity (Doyle, 2011). In a teacher-centered approach, instructors feel pressured to “cover” their course material and they march through the textbook material to ensure that every chapter of the book is covered. This learning is inert and does not result in high levels of transfer (Bransford, Franks, Vye, & Sherwood, 1989). Wiggins and McTighe (2005) called this approach to teaching, “Teach, test, and hope for the best” (p. 3). In this approach, the implicit assumption is that learning transfer simply takes care of itself. Rogers (1983) argued the need to change teacher-centered learning environments because “students become passive, apathetic, and bored” (p. 25). The incorporation of real-time polling can enhance students’ levels of engagement and participation (Patry, 2009) because it can help shift learning environments from teacher-centered to learner-centered by requiring students to participate by using their polling device to respond to polling questions (McCabe, 2006).

Deep Understanding.

The second characteristic of classes that enhance learning transfer is that students need to move from simple memorization to deep understanding with abstract and contextual knowledge. Students become engaged when given opportunities to experience abstraction, which is the process of allowing students to apply the content to other contexts (Bransford et al., 2000). Students also need to move beyond the lower-level thinking skills such as remembering and understanding and move to the higher-order thinking skills of applying, analyzing, evaluating, and creating (Krathwohl, 2002; Renkl, Atkinson, Maier, & Stanley, 2002).

Mazur (1977), a Physics and Applied Physics professor at Harvard University, began using real-time polling to ensure his students had deeper levels of understanding. Mazur continues to use real-time polling to deepen students’ understanding by interspersing his lectures with conceptual questions that are designed to expose challenges in understanding the material. The questions he uses require students to use their higher-level application skills to be able to provide a response. Mazur gives students a few minutes to deliberate, and then must commit to an answer by using the polling device. Using this methodology allows instructors to quickly gauge students’ understanding through the instructor response dashboard that summarizes the students’ responses (Miller, Lasry, Lukoff, Schell, & Mazur, 2014). When classes have high levels of misunderstanding, Mazur asks students to spend a few minutes in groups of three or four in order for them to reach consensus on the correct answer. Students then need to think through their arguments and discuss them with other students; this process allows them to deepen their level of understanding and also clarify any misunderstandings. Since students are trying to convince each other of the correct answer, this type of teaching methodology is called peer instruction (Mazur, 1997). Following student discussions, instructors have students use the polling device to vote again. Instructors can then share the correct answer and respond to any lingering questions or provide clarification, if needed. The use of real-time polling in peer-instruction is an excellent strategy to help enhance students' learning transfer because it requires students to be actively engaged. Students need to apply their knowledge and then defend their answers, instead of simply sitting passively in class and taking notes (Lambert, 2012).

Frequent Assessments.

The third characteristic of classes designed to maximize learning transfer is that students are actively involved with frequent assessments that are distributed throughout the class. Students should not be assessed with one-time tests such as a single mid-term or final exam, but be continually assessed using active, dynamic, and continual processes (Bransford et al., 2000). Incorporating polling into each and every class requires students to be continually assessed, which requires them to stay engaged and results in better long-term retention (Pashler, Rohrer, Cepeda, & Carpenter, 2007). Polling can also allow students to review course content by assessing prior knowledge (Abrahamson, 1999). Once stored, it is important to continue to review the information on a regular basis, thereby strengthening connections between neurons (Willis, 2006).

Instructors teaching Educational Psychology at the University of California found their students scored significantly higher on exams when they used clickers during class as formative assessments to respond to frequent exam-like questions compared to students enrolled in classes not using clickers. The researchers felt the clickers increased student learning because: (a) students needed to pay closer attention to the course material to be able to correctly answer the exam-like questions; (b) students needed to organize and integrate their course material in their brains while formulating answers, and (c) students develop metacognitive skills for gauging their levels of understanding of the course material (Mayer et al., 2009).

Instructors teaching a large enrollment introductory psychology class embedded questions throughout the lecture as a formative assessment method to test students' level of understanding. The researchers found the students in classes using clickers had significantly higher scores ($p < .05$) than students enrolled in sections not using this teaching methodology (Powell, Straub, Rodriguez, & VanHorn, 2011).

Increase use of Senses.

The fourth characteristic of classes designed to encourage higher learning transfer is that students are required to use more of their senses (Seitz, Kim, & Shams, 2006). Real-time polling can be used in class to help students utilize more of their senses while learning course content. For example, students use their visual memory when seeing the questions, problem sets, and possible answers displayed on PowerPoint slides. Students also use their auditory memory when hearing their instructor talk about the questions and later, if students are to discuss the answers with their peers. Additionally, students use their tactile-kinesthetic memory when moving their body from a potentially bored, inattentive, passive listener position to a more alert one in which they prepare to use the polling device to choose an answer. Furthermore, students also activate their feelings of excitement as they begin to generate eagerness when they are required to make a choice on the polling device. The more senses students use in practicing their learning, the more pathways become available for recall (Seitz et al., 2006). Implementing multisensory learning environments allows for more effective learning transfer for longer periods of time (Medina, 2008). “Learning will happen more effectively if the learner is as involved as possible, using as many of his [or her] faculties as possible, in the learning” (Crosby, 1981, p. 10).

Visible Learning.

The fifth characteristic of classes that are designed for strong learning transfer is that classes include activities that require students to make their learning visible, clarify any misconceptions, and develop their metacognition (Bransford et al., 2000). Metacognition is a person’s awareness of their own thinking and their ability to plan, monitor, evaluate, and repair cognitive learning (Kirsh, 2005). Incorporating real-time polling with appropriately crafted questions is an excellent strategy to help students strengthen their metacognition because it requires students to repeatedly and frequently apply knowledge to answer questions and receive immediate feedback about their level of understanding of the topic (Manke-Brady, 2012). This is important because Halpern and Hakel (2003) found that students are poor judges of how well they understand complex topics and will develop misunderstandings if they do not have ways to accurately judge their levels of understanding. Chabris and Simons (2009) outlined why students’ develop misunderstandings by explaining that people have challenges with their perception, memory, attention, and reasoning. They went on to note that people frequently miss a lot of things happening around them, but due to inattentional blindness, they have no idea what they are missing. Developing lessons that help students identify their misconceptions allows them to learn content at deeper levels for longer retention.

Increased Participation and Engagement.

The sixth characteristic in classes designed for effective learning transfer is that classes are designed to require students to have high levels of participation and engagement in order to keep students’ attention. Penner (1984) found that student attention and concentration drops off dramatically after 10 to 15 minutes. Research studies have shown that the human brain is not equipped to pay attention to auditory information for long periods of time, regardless of the students’ grade level or ability (Milton, Pollio, & Eison, 1986). Bligh (2000) conducted research to show that when students spend prolonged periods of time on a repetitive task such as note taking, their lower centers of the brain (mindless behavior) becomes activated. Research in neuroscience has suggested that students need to practice and use information to allow them to see how the information has interconnections and how it can be used in other contexts to enhance learning transfer (deWinstanley & Bork, 2002). If students are going to achieve learning beyond lower-level information acquisition, they need to be actively engaged in the process of learning (Pascarella & Terenzini, 2005). “If we want students to become more effective in meaningful learning and thinking, they need to spend more time in active, meaningful learning and thinking- not just sitting and passively receiving information” (McKeachie, Pintrich, Lin, & Smith, 1986,

p. 77). Incorporating real-time polling is a good way to break-up long lectures (Addison, Wright & Milner, 2009) and will ensure that students have high levels of engagement and participation which will lead them to develop stronger neural connections to maximize learning transfer (Doyle, 2011).

Research Questions

The instructors involved in this research study attempted to utilize the real-time polling in their classes to maximize learning transfer of students by increasing students' levels of engagement and participation. The researchers attempted to answer the following questions:

1) Does the use of real-time polling have an impact on students' perceived levels of participation and engagement?
2) Does the use of real-time polling have an impact on students' perceived ability to understand the course material?

Method

Three instructors in five different classes used real-time polling in an attempt to increase students' levels of engagement and participation in order to enhance students' learning transfer.

Demographics

The students in this research study were enrolled in classes at a mid-sized university in the Midwest in the United States. The survey was given to 97 participants in five different classes taught by three different instructors. There were two students who did not have a device to utilize for the real-time polling and could not participate, so they only completed the demographics section of the survey. The students in the survey were majoring in Organizational Leadership, which is designed to prepare them to become managers and supervisors in the private, public, and nonprofit sectors. All students taking the survey were undergraduates with the majority being seniors (N = 56), the next being juniors (N = 39), and the least of them being sophomores (N = 2). The age of the participants ranged from 18-24 (N = 57), 25-30 (N = 21), 31-40 (N = 9), 41-50 (N = 9), and 50 and over (N = 1). The gender make-up of the participants was more male (N = 53) than female (N = 44). The racial mix of the participants was Caucasian (N = 72), African American (N = 21), Other (N = 2), Asian (N = 1), and Hispanic/Latino (N=1).

Instrument

Students were asked to complete a paper and pencil survey to measure their perceptions of using the Poll Everywhere real-time polling. The survey was administered by someone other than the classroom instructor, to assure students' privacy. The survey was administered during the last week of a semester class. Students completed a 49-question survey that was developed by the researchers. The survey included questions about students' demographics, the type of device they used, their level of participation and engagement, their thoughts about learning transfer, and their thoughts about using real-time polling in the future. Utilizing a Likert Scale, students responded to statements with a (1) Strongly Agree (SA), (2) Agree (A), (3) Disagree (D), or (4) Strongly Disagree (SD). Additionally, students were asked to provide comments about the impact of real-time polling on their level of understanding, satisfaction, participation, and engagement by responding to open-ended questions.

Procedure

Instructors in five different classes asked students to use Poll Everywhere as a real-time polling device to respond to polling questions while teaching their classes. Students used their personal devices (cell phones, lap top, or tablet) to respond to these real-time polls. Quantitative data were gathered from students by asking them to complete a survey questionnaire that asked students to give their perceptions about how the use of real-time polling had an impact on their level of understanding and their level of participation and engagement. Students were given statements such as "Using real-time polling during class helps me to better understand the class material" and then select if they (1) Strongly Agree, (2) Agree, (3) Disagree, or (4) Strongly Disagree. Students' Likert scale responses were entered into an Excel spreadsheet and then imported into SPSS 21 for quantitative data analysis. On the quantitative survey, there were six questions designed to measure for student participation and nine questions designed to measure for engagement. Exploratory factor analysis (EFA) with principal axis factoring and varimax rotation was used to identify the underlying relationships between the survey items (Norris & Lecavalier, 2009). Results are displayed in Table #1. Principal axis factoring assumes all variables have been measured with some degree of error (Kim & Mueller, 1978). Varimax (orthogonal) rotation attempts to minimize the number of variables that have high factor loadings, thus interpretability of factors can be enhanced. Bartlett's test of sphericity (χ^2=651.93, p<.01) indicates the correlation matrix is an identity matrix; thus data appear to be a sample from a multivariate normal population.

Table 1. Rotated Factor Matrix

	Factor		
	1	2	3
Q23		-.545	
Q24	.461	.736	
Q25	.583	.465	
Q26	.684		
Q27	.707		
Q28			.380
Q31	.686		
Q32	.764		
Q33	.766		
Q34	.709		
Q35			-.442
Q36	.722		
Q37	.783		
Q38	.760		
Q39	.571		.490

The most conservative approach to interpreting the rotated factor matrix was employed; thus any items that loaded across multiple factors were removed. The final variable, Classroom Engagement and Participation, is comprised of items 26, 27, 31, 32, 33, 34, 36, 37, and 38. The Cronbach's Alpha for Classroom Engagement and Participation is .92, which indicates an excellent level of internal consistency among these questions (George & Mallery, 2011).

Qualitative data were gathered from opened-ended questions where students were asked two open-ended questions about their thoughts about how the use of real-time polling impacted their comfort level speaking in class and how it impacted their level of attention and engagement. The responses to opened-ended questions were imported into NVvio 10 research software for qualitative analysis to group with common themes.

Results

The results section summarizes the results from the student survey that measures students' perceptions about the incorporation of real-time polling in their class.

Research Question #1

The first research question asked if the use of real-time polling had an impact on students' level of participation and engagement. In total, there were nine questions on the survey measuring the impact. Cronbach's Alpha, the measure for internal consistency, revealed internal consistency of .92 which indicates an excellent level of internal consistency (George & Mallery, 2011). These nine questions were combined to develop a total score to summarize students' perceptions of how the use of real-time polling had an impact on their level of participation and engagement (M = 1.5; SD = .45.).

Four of these questions about students' level of participation and engagement asked students how the use of real-time polling impacted their classroom communication (see Table 2). The questions which the students agreed with from most to least included: (1) I feel that using real-time polling during class enhances the quality of discussions (M = 1.46); (2) I like that my polling responses are anonymous (M = 1.48); (3) The use of real-time polling in class enhances controversial discussions (M = 1.51), and (4) Using real-time polling in class makes me feel as if I have a voice to contribute during class discussions (M = 1.71).

Table 2. Real-time polling survey: Participation & Engagement questions

	N	SA (1)	A (2)	D (3)	SD (4)	*M*	*SD*
1) Q #32: I feel that using real-time polling during class enhances the quality of discussions.	94	51 54%	43 46%	0 0%	0 0%	1.46	.50
2) Q #27: I like that my polling responses are anonymous.	94	52 55%	39 42%	3 3%	0 0%	1.48	.56
3) Q #34: The use of real-time polling in class enhances controversial discussions.	95	51 54%	40 42%	4 4%	0 0%	1.51	.58
4) Q #26: Using real-time polling in class makes me feel as if I have a voice to contribute during class discussions.	94	37 39%	47 50%	10 11%	0 0%	1.71	.65

There were three questions that asked if students felt the use of real-time polling increased levels of participation and engagement because it impacted their enjoyment (see Table 3). The questions students agreed with from most to least included: (1) I like using a personal mobile device to engage in real-time polling during class (*M* = 1.36); (2) Using mobile devices for real-time polling during class is fun (*M* = 1.40); and (3) I wish that other instructors would use real-time polling in their classes (*M* = 1.49).

Table 3. Poll Everywhere Survey: Enjoyment and fun questions

	N	SA (1)	A (2)	D (3)	SD (4)	*M*	*SD*
1) Q #31: I like using a personal mobile device to engage in real time polling during class.	95	63 66%	30 32%	2 2%	0 0%	1.36	.52
2) Q #33: Using mobile devices for real-time polling during class is fun.	95	60 63%	32 34%	3 3%	0 0%	1.40	.55
3) Q #38: I wish that other instructors would use real-time polling in their classes	95	50 53%	43 45%	2 2%	0 0%	1.49	.54

There were two questions on the survey (see Table 4) that measured students' thoughts on whether they believed real-time polling kept them engaged and attentive. The questions with which the students agreed with from most to least included: (1) I feel more connected to the class when participating with real-time polling (*M* = 1.65) and (2) I become attentive when my instructor directs us to respond using real-time polling (*M* = 1.67).

Table 4. Poll Everywhere Survey: Engagement questions

	N	SA (1)	A (2)	D (3)	SD (4)	*M*	*SD*
1) Q #37: I feel more connected to the class when participating with real-time polling.	94	43 46%	42 44%	8 9%	1 1%	1.65	.68
2) Q #36: I become attentive when my instructor directs us to respond using real-time polling.	95	39 41%	48 51%	8 8%	0 0%	1.67	.63

Open-ended comments were grouped into categories where students indicated the use of real-time polling had an impact on their participation and engagement. The two categories identified were an impact on their active participation and also their levels of participation and engagement. In the first category of active participation, some students felt the real-time polling allowed them to be more fully active in the class for those students that were shy and they felt the polling gave them a voice (see Table 5).

Table 5. Student comments about effect of real-time polling on giving them a voice

1) Sometimes I can feel uncomfortable speaking in class, this definitely provides an outlet for people to be heard, no matter what the comfort level AND takes less time than hearing everyone's opinion.
2) I get nervous speaking in front of people and with the polling I can still get my statement made without being shy.

Some students felt they could be more active in the classroom using real-time polling because it allowed them to respond anonymously and they could express their opinions without being judged (see Table 6).

Table 6. Student comments about effect of real-time polling on being judged

1) I don’t speak up b/c [sic] I am often the one who knows the answers and don't want to be the “teacher's pet”.
2) [I don’t speak up because I] feel uncomfortable when I think people are judging my disability.
3) I love that it is anonymous, I don’t feel judged or anxious.

Some students did not believe that real-time polling had any effect on their active participation because they felt comfortable speaking up in class and commented, “I prefer getting credit for my ideas rather than anonymous responses.”

The second category identified in the open comments was related to comments regarding how real-time polling impacted their levels of participation and engagement. The majority of comments from students indicated that the use of real-time polling had a positive impact on their level of engagement. Most students felt that the use of real-time polling helped them to stay focused and have fun with comments such as those listed in Table 7.

Table 7. Effect of real-time polling on participation and engagement due to focus and fun

1) Just makes you pay attention.
2) It keeps things moving and energetic! It’s not just passing through lecture slides [and] offers something more.
3) It makes class fun.
4) Feel more engaged.

Students also felt the use of real-time polling impacted their levels of participation and engagement because it allowed everyone in the class to feel included (see Table 8).

Table 8. Effect of real-time polling on participation and engagement due to inclusion

1) They are a good way to interact with the class and keep everyone involved.
2) I think it allows everyone to feel like they can contribute to the class discussion.
3) I don't mind speaking up in class. I sometimes have exactly the same thing to say as someone else and that may be why I don't say much but I also enjoy using the Real time polling because it gives the whole class a voice.

Research Question #2

The second research question asked if the use of real-time polling had a perceived impact on students’ ability to understand the course material. There were 90% of the students who strongly agreed or agreed (see Table 9) that the use of real-time polling helped them to better understand the material (M = 1.84, SD = .57).

Table 9. Poll Everywhere Survey: Perceived Student Learning

	N	SA (1)	A (2)	D (3)	SD (4)	*M*	*SD*
Using real-time polling during class helps me to better understand the class material.	94	24 (25%)	61 (65%)	9 (10%)	0 (0%)	1.84	.57

A bivariate analysis was conducted to determine the empirical relationship between Perceived Student Learning and Classroom Engagement and Participation. The bivariate correlation between the two variables of Perceived Student Learning and Classroom Engagement and Participation is significant ($r=.55$, $p<.01$, $n=91$). There was evidence to conclude there is a significant association between Classroom Engagement and Participation and Perceived Student Learning.

To evaluate differences in perceptions between individuals with high perceptions of learning transfer (comprised of Strongly Agree and Agree) and low perceptions (comprised of Disagree and Strongly Disagree), an independent sample t-test was computed using Classroom Participation and Engagement as the test variable and Perceived Student Learning as the grouping variable (Group 1=Strongly Agree and Agree; Group 2=Disagree; Note; 0 responses for Strongly Disagree). Results indicated the difference ($MD=.52$, $t(9.60)$ -3.50, $p<.001$, equal variances assumed) between students with higher perceptions of learning transfer reported greater perceptions of overall engagement than students with lower perceptions of learning transfer ($m=1.48$, $n=82$, s$d=42$; $m=2.00$, $n=9$, s$d=.42$, respectively, where lower scores indicate higher levels of perceived overall engagement).

Open-ended comments were grouped into categories where students indicated the use of real-time polling had an impact on their learning. The three categories identified were visible learning, frequent assessments, and deeper learning. Students felt that the use of real-time polling allowed instructors to craft questions where students' responses help make learning visible. Students made comments in the first category with comments such as comments in Table 10.

Table 10. Impact of real-time polling on students' learning by making learning visible

1) Totally engages you and you know what your level of understanding is.
2) I really enjoy this. I think it keeps students involved while in class. It reminds me of how when you're in grade school and you write your answer on your white board.
3) It lets you see how almost the whole class views a particular subject.
4) I felt that polling allows me to see how others feel

Another category that was identified from open comments was that instructors could use real-time polling to quickly and frequently assess students (see Table 11).

Table 11. Impact of real-time polling on students' learning with frequent assessments

1) Sometimes I can feel uncomfortable speaking in class, this definitely provides an outlet for people to be heard, no matter what the comfort level AND takes less time than hearing everyone's opinion.
2) I felt it was a faster way to get my point and answer across.
3) I thought it was great, makes me feel accountable.

The third category identified from open comments was that instructors could use real-time polling to encourage deeper learning. Students reported that when results of real-time polls were displayed, it sparked a good class discussion (see Table 12).

Table 12. Impact of real-time polling on students' perceived learning with deeper learning

1) I fell helps start good class discussion.
2) I like seeing the results pop up on the screen and the discussions afterword.
3) I think real time polling helps me to speak in class because it can [help me to] feel comfortable about what I say if I see that others would agree.

Discussion

Bransford et al. (2000) found that it is necessary for instructors to design classes where students have high levels of participation and engagement to enhance students' learning transfer. Design strategies to enhance learning transfer are classes where instructors require students to have active participation, deep levels of understanding, frequent assessments, increased use of their senses, make their learning visible, and high levels of participation and engagement. This section discusses if the incorporation of real-time polling had an impact on these characteristics designed to enhance learning transfer.

Active Participation.

Halpern and Hakel (2003) found that learning transfer is enhanced by requiring students to practice at retrieving content by actively participating instead of passively listening to lectures. Getting students to actively participate in class may be a challenge to many instructors and incorporating real-time polling can give instructors tools to enable this. Some students admitted that they were shy and that real-time polling helped give them a voice (89%). Most students communicated appreciation of the anonymous nature of the polling (97%). Some of the open-ended comments revealed that there were students who felt comfortable speaking in class and that for them, the real-time polling made no difference.

Deeper Understanding.

The incorporation of real-time polling followed by class discussion has been shown to deepen students' understanding of course concepts (Mazur, 1977). The students in this study overpoweringly indicated that the use of real-time polling helped them to better understand the class material with 90% agreeing with this statement. Students unanimously agreed that the use of real-time polling helped the quality of the discussion with 100% agreeing and 96% of them indicating that it enhanced controversial questions. Students felt the real-time polling encouraged deeper understanding because the results of the polls would be displayed and spark a good discussion. Some students felt more comfortable joining the discussion when they could see their opinions would be supported from the poll results.

Frequent Assessments.

Karpicke and Roediger (2006) found that when study preparation time is equal, students that used assessment tools in their study preparation significantly improved their long-term retention compared to students using review methods for studying. Incorporating assessments requires students to be actively involved in their learning since their brain is retrieving information and the effort deepens and strengthens their neural connections (Larsen, Butler, & Roediger, 2013). Students in this study reported the incorporation of real-time polling allowed instructors to quickly and frequently assess students with polling questions. Instructors that incorporate real-time polling requires all the students to actively engage with assessment by responding to the polling questions, instead of a few that might verbally answer a question during class. The regular incorporation of real-time polling made some students believe they were accountable since they were being frequently polled.

Increased use of senses.

Many classroom instructors can intuitively read their students' body language to judge their level of alertness. The instructors noted that students' physical demeanor would change when polling questions were included by moving from a relaxed posture to an attentive and engaged demeanor. Students use more of their senses when asked to pick up their real-time polling device as they are seeing the question, touching their responding device, and feeling the excitement as they prepare to select their response. Seitz et al. (2006) found that the more senses that students use while learning the better as more pathways become available for recall. There were 92% of the students felt the use of real-time polling required them to become more attentive.

Visible learning.

Traditional studying methods such as reading the textbook and highlighting the course material can cause students to have a "fluency illusion" because they understand the material and believe they have mastered the content (Carey, 2014). The students in these classes reported that the use of real-time polling allowed the instructor to make learning visible when they displayed the aggregate results of each poll. This allowed students to see how the other participants in class felt about the questions or how they stacked up against their peers. One student compared the use of real-time polling to the process of going to a whiteboard to make their learning visible.

Increased participation and engagement.

The majority of university classes last from 50 to 90 minutes, which is much longer than the typical attention span of most college students. Bunce, Flens, and Neiles (2010) found that classes designed using real-time polling to enhance active learning results in fewer attention lapses due to the engaging of students' attention. The student in this research study indicated that the use of real-time polling helped them feel higher levels of engagement with most of the students indicating that they wished other instructors would implement it (98%). Students felt that using real-time polling was fun (97%), and made them more connected to the class (90%). The open-ended comments supported this with almost all comments conveying that real-time polling helped to get their attention.

Considerations for Implementing Real-Time Polling

Instructors will not only face challenges in learning the technical steps of setting up real-time polling, but also face pedagogical challenges to ensure the implementation of real-time polling results in learning enhancements. Many universities will offer technical training workshops which will help instructors learn practical applications, but few offer workshops in pedagogical implementation. A suggestion would be to implement real-time polling with a colleague and take turns conducting peer-reviews of each classroom. Another advantage of implementing real-time polling with a colleague is that instructors can practice together and brainstorm technical and pedagogical issues to develop solutions.

Based on this study, the researchers have some suggestions for instructors who wish to incorporate real-time polling into their classroom. The first consideration is to ensure that most students have a cell-phone or device to participate in the real-time polling. The results from this research study showed that 98% of students had cell phones which allowed them to participate. Of those students who had cell phones, 100% of them indicated that they would prefer using their cell phone for the real-time polling instead of purchasing a "clicker device." Since the majority of students had devices which allowed them to participate, instructors were quite pleased when they were able to quickly query the class and get a response from most students. While there were two students who indicated that they did not have a cell phone and could not participate, the researchers felt that they obtained a much larger number of students participating than they would have normally during class discussions without the use of real-time polling.

Instructors may also face technical challenges when implementing Poll Everywhere. The Poll Everywhere technology requires that students use their own texting service to respond to real-time poll questions. Therefore, students' phones need to have robust enough phone service to be able to text responses. Since the real-time polling required students to text their responses, this was sometimes a usability issue for those students who were unfamiliar with how to use their texting tool on their cell-phone. Additionally, students who used feature phones (non-smart phones) to text their answers were at a disadvantage because it took longer for them to text their response and doing so was a substantially more cumbersome process.

Another challenge for instructors to be aware of is that for Poll Everywhere real-time polling, students are charged for each text that is sent to respond to a question. The costs incurred for texting would normally be far less than the $40 for the cost of a clicker device, even though the cost for required clicker devices may be covered by tuition assistance, where data plan costs normally would not. Several of the students provided open-ended comments that indicated they did not have issues with texting by saying, "I think everyone has unlimited texting."

Instructors should also be aware that the time of day may have an impact on students' ability to participate using their own cell phone. For example, during evening classes students' cell phone batteries may begin to lose power and students may want to spare cell-phone use to ensure power for their ride back home.

The classroom environment should be considered by instructors before implementing real-time polling that requires students to use their own cell-phones. Evening classes or lack of phone access may require instructors to use traditional "clicker devices." However, if the environment supports students' use of their own cell phone device, it can save students money as well as the additional burden of having to bring an additional "clicker device."

Significance of the Study

The ultimate goal for higher education needs to be transfer of learning so that students can take the knowledge learned and utilize it when employed and the instructor is not there to help them. Instead of teaching students to successfully complete midterms, instructors need to design their classes to prepare students to independently use the knowledge in an unpredictable real world situation (Halpern & Hakel, 2003). Real-time polling can be used to help implement design characteristics that increase students' levels of engagement and participation that will enhance learning transfer. Companies like Poll Everywhere now have real-time polling solutions where students no longer need to purchase "clicker devices", but can use their existing cell-phone to respond to real-time polls. Allowing students to use their own device to participate in the real-time polling not only saves them money, but eliminates the need of having to bring an additional device to class since most students usually have them readily available.

Study Limitations

This study relied on the perceptions of students who responded to a survey. The study also relied on three different instructors implementing real-time polling in their class, so some variation on instructors' levels of expertise in conducting the polls was expected, which might have affected the results. This study asked for students' perceptions if the use of real-time polling increased their understanding of the course content and did not measure assessment results. Another limitation is that the researchers were also the instructors of these courses and this duplicity of roles may have affected their objectivity in analyzing the student responses.

Suggestions and Recommendations for Further Research

Almost all the students in this study had devices to use for real-time polling with 98% of students owning cell phones. This allowed students to participate in real-time polling without the necessity of spending extra money for a "clicker" device. A suggestion for further research would be to compare students' perceptions of engagement and participation in classes where students are required to purchase "clicker" devices to classes where students use their own cell phone.

The data for this study was gathered from a survey given to students. A recommendation for further research would be to conduct interviews with students to elicit anecdotal information to gather deeper understandings of how students perceived the use of real-time polling had an impact on their level of understanding course material, their level of participation, and their level of engagement. This study was conducted in one department at one university. Another suggestion for research could be to conduct the study with different academic departments and/or different universities to see if there is a difference with the results, especially if the instructor is not also conducting the study.

Final recommendation for future studies would be to expand the use of real-time polling to teaching students how to utilize the technology. Ninety three percent of students indicated on the survey they felt that using real time polling could benefit their professional life and ninety-two percent indicated that it would be a marketable skill that could be help differentiate them. In the classes used for this study, the instructor conducted the real-time polling and the students who responded to the polling questions. A recommendation for further research would be to have the students facilitate real-time polling in their presentations to see if their perception of the value of using real-time polling increases.

Conclusion

The purpose of higher education to ensure learning transfer is so that our students can take the information learned while enrolled in classes and be able to recall and implement this learning when employed at a later date in situations that are different than the classroom. "Teaching for retention during a single academic term to prepare students for an assessment that will be given to them in the same context in which the learning occurs is very different from teaching for long-term retention and transfer" (Halpern & Hakel, 2003, p. 38). Instructors can use real-time polling to design classes that enhance students' learning transfer. The use of real-time polling will allow students to "practice at retrieval" (Mayer et al., 2008) by providing instructors with frequent opportunities in which they can encourage their students to apply learning while responding to polling questions. Furthermore, real-time polling enables students to develop their metacognition (Halpern & Hakel, 2003) because they are able to check their own understanding by comparing their own responses to the correct answers. The incorporation of real-time polling will facilitate instructor adoption of more learner-centered strategies that allow students to assume more responsibility of their learning, and also ensure that students are in active learning environments instead of being passive recipients of knowledge (Doyle, 2011).

The instructors involved in this study redesigned their courses using real-time polling to enhance their students' learning transfer. The results of the survey showed that students reported perceived higher levels of participation and engagement. Students' responses also demonstrated that they concluded that the use of real-time polling overwhelmingly helped them to better understand the content.

Based on the statistically significant positive relationship between the variable of Engagement and Participation and the other variable of perceived student learning (r=.55, p<.01, n=91), it can be concluded that use of real-time polling does engage students. This engagement has been shown to have a positive impact on perceived student learning.

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Echoes from the Past: Podcasting in the African American Studies Classroom

Cassandra Jones[1]

Keywords: podcasting, instructional technology, African American Studies, digital citizenship

Framework

Podcasting has been used to deliver lectures in traditional face-to-face, hybrid, and distance-learning classrooms. However, an increasing amount of research has explored the educational benefits of student-created podcasts. Jarvis and Dickie (2010) have noted that podcasting can allow access to deeper modes of learning. In addition to digital literacy skills, podcasting has been shown to promote confidence and provide greater motivation for participating in the course (Lee et al, 2008).

When implementing technology in the classroom my primary goal as an educator is to use it in service of the core content. As a result, this podcasting project firmly places African American Culture at the center at both phases of the project: learning how to use the podcasting software and creating a podcast to share with the class.

This quick hit describes the use of podcasting using Audacity, a free audio-editing software program, as implemented in an African American Culture class made up of 35 students. The ethnography podcast replaced a typical research paper with the aim to achieve this greater motivation and engage deeper modes of learning by asking students to explore their connections to the African American communities around them.

Making It Work

Phase 1: Learning to Use Audacity

Phase one of the project was a workshop in which students learned how to use Audacity to record, import, edit, and export audio files. These audio files, exported as .mp3s, were uploaded both to Blackboard and to a private iTunesU course page. In the two-day workshop, students were given a mini-podcast assignment through which they learned the skills they would need for the final project. Upon completion of the assignment, students had produced a one-minute mini-podcast in which the student introduces him- or herself, the title of the podcast, and frames the interview content making connections to course concepts. The assignment had the additional benefit of allowing me to incorporate supplementary historical resources into the class.

The workshop was held during two 50-minute course sessions. In order to give a group of 35 students as much guidance as possible, I requested the help of our campus's instructional design and assistive technology assistant, Winona Hatcher. We decided on iTunesU as an appropriate place for students to submit their finished products in order to give them the feeling

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of having completed a professional podcast. As our campus has recently begun a “Bring Your Own Device (BYOD)” initiative, our students own laptops in greater numbers. These devices are also available from our Information Technology Help Desk to be borrowed for a 7-day period for students who do not own laptops. I asked the students to download and install Audacity onto their devices (using IT for guidance if necessary) before the workshop began, encouraging them to explore the program on their own as well.

Day one of the workshop asked students to edit an .mp3 recording from the Library of Congress’s American Memory Collection of Slave Narratives. I provided a digital handout listing the goals for these two days with instructions on how to proceed. I showed students a YouTube video that outlined the Audacity skills they would need for the assignment, providing a link on the handout for reference. I then demonstrated these steps for them. Students chose a slave narrative to download and import into Audacity. After opening the .mp3 file, they edited it down to a 30 second clip that they could connect with course concepts. While students did this, Ms. Hatcher and I answered questions or dealt with technical difficulties. Students who moved swiftly through the assignment were encouraged to help students with questions around them or move on to the homework assignments.

In preparation for day two, students were required to reflect on the selection they had chosen and draw connections to course content. As homework, students composed and recorded an introduction to the podcast that welcomes the listener to the podcast, includes the student’s name, the name of the interviewee, and frames what the listener will hear. Headphones and microphones are also available for students from the Information Technology Help Desk. I provided the students with an example of an introduction I had created for my own mini-podcast for reference.

Day two of the workshop built on the skills of downloading, importing, editing, and recording developed on the first day and asked students to layer each of their assembled pieces and export the files as a singular .mp3 file to be uploaded to Blackboard and our iTunesU course pages. We briefly reviewed the video, focusing on adding tracks, using the time shift tool to stagger them effectively, using the envelope tool to increase or decrease the volume of a track to more smoothly edit transitions between tracks, and exporting completed .aup files as .mp3 files. In addition, I reviewed the process of uploading the finished product to our Blackboard and iTunesU course pages. I discussed the importance of choosing copyright-free music and digital citizenship, including extending proper credit to others’ creations and urged students to choose copyright-free music to serve as intro/outro music, to play behind their own speech track, or behind the interview for emotional affect.

Students downloaded and imported an .mp3 of copyright-free music to set the tone for their podcast, editing for time. Students used the envelope tool to alter the music’s volume and the time shift tool to layer the music behind either their introduction and/or the recorded slave narrative. Once they had completed the mini-podcast to their satisfaction, they exported the file and uploaded it. In order to encourage students to engage each other’s work, I assigned additional credit for listening and responding to the mini-podcast in a 150-word minimum post on Blackboard. The assignment allowed me to keep African American Studies content at the center of a lesson about using technological tools.

Phase 2: Creating and Sharing the Ethnographic Podcasts.

This workshop prepared students to complete a longer podcast on their own. The semester-long assignment involved several steps before the completion of the five to seven minute ethnographic podcast. Choosing an area of African American culture to explore, students wrote a topic proposal, demonstrating their awareness of available research as well as naming specific interview subjects. Then they recorded the interview(s) with their subject(s). Next, they composed an annotated bibliography listing four to five sources. The fourth step was bring the recorded interview(s) and laptop to class for a final 50-minute workshop day. This workshop day was devoted to editing the final podcast with both the instructor and technology assistant available to help with any technical issues. As the final stage in the process, I asked students to share their podcasts with each other on Blackboard and the iTunesU course page. Students were evaluated based on their participation in the workshops, the quality of their research, the podcast's content, meeting length guidelines, and attention to digital citizenship.

Future Implications

Despite claims about millennial students as digital natives, many of my students were anxious about using this technology. They did not see podcasting as an accessible skill. A few students were familiar with audio editing from their other classes or their own interest in music production, but many were learning this skill for the first time and found themselves intimidated by the abundance of options presented by the program. In keeping with Lee, McLoughlin, and Chan's findings, as they completed the mini-podcasts, students became more confident in their use of the technology and were able to successfully complete longer format podcasts (Lee et al, 2008). While I have only anecdotal evidence to support this, the use of podcasting did seem to generate excitement about the course and thus greater motivation to participate.

With such a large group of first-time podcasters, Winona Hatcher's presence as an additional instructor on hand for the workshops was invaluable. For instructors without a technology pedagogy coordinator, perhaps requesting the presence of an IT technician would help with the inevitable technical issues that present themselves.

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AN INTERPROFESSIONAL APPROACH TO A DISTANCE LEARNING DILEMMA

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Keywords: distance education, inter-professional collaboration, storyboarding, nursing, advanced practice education

Framework

Teaching is not an activity that is done in isolation. It takes colleagues with diverse talents and skills to create and build effective learning tools that improve student learning outcomes. Content, pedagogy, and technical expertise are required when new learning technologies are developed.

Learning in a practice discipline, such as advanced practice nursing, can be particularly challenging. Students must assess, diagnose, and provide care for diverse populations. Their ability to be proficient at these skills could make a difference in whether a patient lives or dies. This is a high stakes profession and the education preparing practitioners is high stakes education.

Teaching nurses to become nurse practitioners is difficult under any circumstances, but when the student is part of a distance learning program the opportunity to role model professional behaviors can be elusive. The American Association of Colleges of Nursing reports that there are currently 65 distance learning nurse practitioner programs with 31 offering their programs entirely online. Almost 22% of all post-masters Nurse Practitioner programs offer distance education (AACN, 2014).

A differential diagnosis course that was previously taught in an on-campus setting needed to be restructured for students at a distance. The class, which teaches the art and science of differential diagnosis, is foundational in the nurse practitioner program. Learning the method of differential diagnosis assists experienced registered (baccalaureate) nurses in upgrading their critical thinking, information gathering, and decision-making skills to those of an advanced practitioner.

On-campus students have the opportunity to conduct a patient interview with a standardized patient (SP), an actor trained to portray a patient with a uniform set of symptoms and history. Students gather a history, perform a physical assessment, review diagnostic data, and reach a conclusion about what is going on with the patient. They determine a differential diagnosis list with a rationale based on the information gathered. While the use of standardized patients for practice of clinical examinations is common in medical schools, this experience is provided less often to nurse practitioner students. It was highly valued by our on-campus students, as reported in course evaluations.

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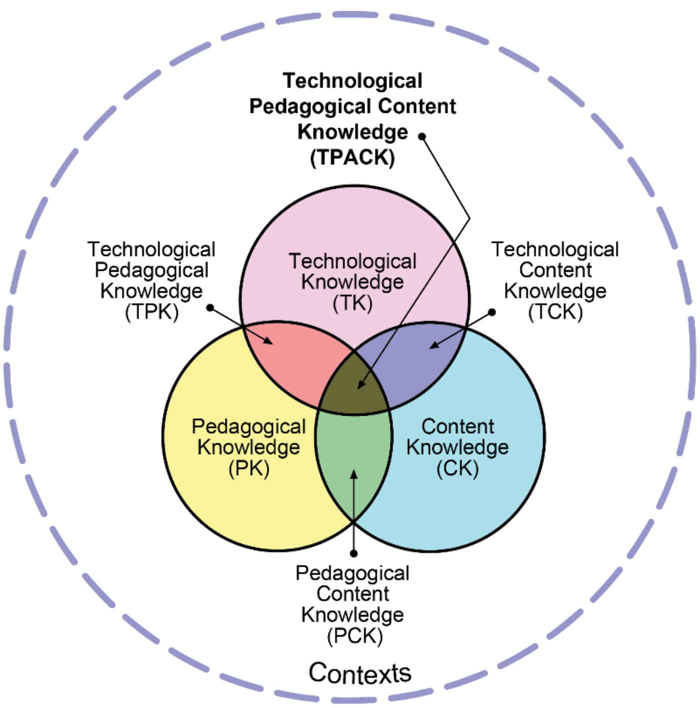
Our problem was determining how we could replicate this experience for our distance learning students who would not be able to personally interact with standardized patients. How could we communicate and role model the subtleties of a patient interview and physical assessment? We wondered if creative use of instructional technology could solve these problems.

The formation of an interprofessional team was required to effectively address our concerns. The team was composed of the course faculty, an instructional designer, and an information technology expert. Using the TPACK Model (Figure 1), team members worked together to create, develop, implement, and evaluate an interactive case study (ICS). The TPACK Model describes the positive interactions that flow from a synergistic relationship among the faculty, instructional design expert, and the instructional technology expert (Koehler & Mishra, 2008). Utilizing this model gave the team a visual that demonstrated the value and inter-dependency of each member.

The plan was to create an ICS accessible to distance learning students that mirrored the experience of interacting with a SP. This ICS is unique because it is done in the first person to role model the process and art of differential diagnosis while allowing the student to feel present at the encounter.

Figure 1

TPACK model



Source: http://www.tpack.org/

Making it Work

This project was successful because people with diverse skill sets worked together to develop a new approach to nurse practitioner distance education. Each team member came from a unique perspective that required a blending of expertise to develop a cohesive team. All of the team members differed in their educational background and approach to getting work done, and we spoke using a different lexicon.

To help the team coalesce, each member identified their area of expertise and what they would bring to this project. Being aware of the professional differences assisted us to see the value that each member contributed to the whole. There were difficulties along the way with ego and personalities but continually restating the purpose and reaffirming the importance of each member's contributions facilitated the over-arching goal being achieved. We all learned the language of each other's discipline so we could efficiently problem solve.

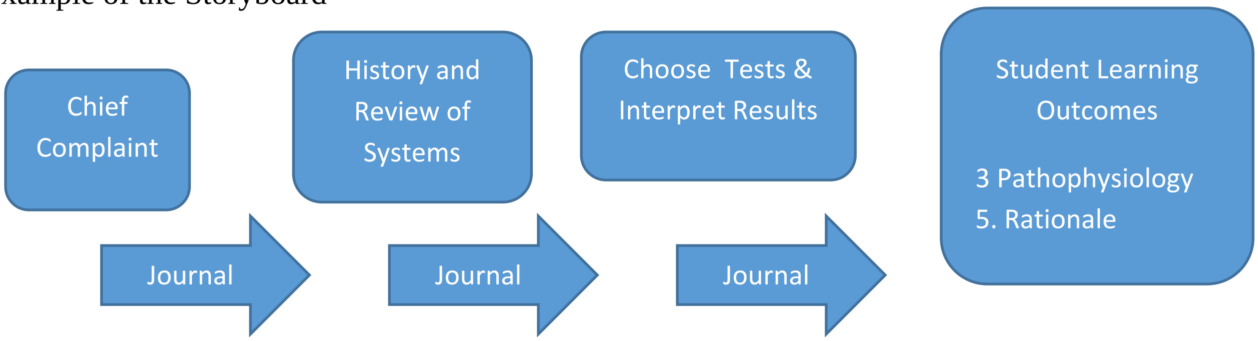
Once the team was in place the faculty member outlined the specific learning outcomes for this new experience. This required significant reflection for the faculty and a sharing of the advanced practice nurses' educational needs with the interprofessional team. Assisting the students in learning the foundational skill of diagnosing became the unifying principle by which every decision was made. Everything that was discussed by the team as a possible learning strategy had this as the endpoint.

The Instructional designer understood distance education and how to achieve learning outcomes using technology, a skill set in which the faculty member had less depth. The design process for the ICS involved using a storyboard to clearly depict how the ICS would move through a given case study. While the nursing faculty member was teaching the instructional designer about nursing, the instructional designer was teaching the nursing faculty about instructional design!

By employing the Backwards Design Model, we were able to move from learning outcomes backwards to instructional strategies (Wiggins & McTighe, 1998). Additionally, by walking through the activity backwards, we determined the best places to insert questions, develop interactivity, assess knowledge, and fold in reflection. Once we completed this portion of the design phase we moved into developing the storyboard. The storyboard provides a physical layout of the plans for progression through the case (Smith & Ragan, 2005).

Figure 2:

Example of the Storyboard



The information technologist (IT) brought the knowledge of how to transform the ideas and strategies into reality. The IT partnered with the instructional designer to build the ICS. Additionally, the IT provided input on the best hardware and software applications and counseled us on how students would manage technological problems. He video-recorded our interactions with the standardized patients and edited the video-recordings. IT controlled sound and video quality, providing adequate lighting and re-filming when audio quality was marginal.

The completed ICS made it possible for distance learning students to engage in a virtual encounter with a standardized patient. ICS components included acquiring the focused health history, participating virtually in a physical assessment, reviewing lab data and diagnostic testing. This data gathering culminates in the student developing a list of differential diagnoses with a rationale. To involve multiple learning domains we asked the students to journal about their preparedness, anxieties, ability to develop appropriate questions, and overall confidence (Kolb, 1984).

Future Implications

After completing the rigorous design and development process we were eager to determine if our distance learning students using the ICS were able to achieve learning outcomes equivalent to those achieved by our on-site students interacting with standardized patients. We conducted a mixed method study that supported the conclusion that the ICS provided distance students with experiential learning with outcomes comparable to those achieved by on-site students (Colella & Beery, 2014).

Working together from an abstract concept to reality was an exciting journey. Faculty need to maximize opportunities to solve educational dilemmas using an interprofessional team. Being aware of the needed steps minimizes confrontation, lack of focus and damage to collegial connections. Education is enhanced by the collaboration of experts, those with the subject matter, design, and technological expertise.

We believe that the Interactive Case Study format is flexible and could be useful to instructors from disciplines outside of healthcare. For example, a history professor could develop an ICS that would allow students to engage in a re-creation of an historical event or an English faculty member could help students engage with a text in an exciting and highly interactive way.

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Pinterest as a Teaching Tool

Sarah E. Schoper[1]

Keywords: Pinterest, disruptive innovation, student engagement, educational technology

Framework

This redesigned student affairs course is taught at the end of the second year in a two-year masters-level program. Students graduating from the program acquire various student affairs professional positions throughout institutions of higher education including residence life, academic advising, student activities and leadership, judicial, campus recreation, and admissions staff positions. The course focuses on understanding and considering ways to take disruptive innovation theory and put it into practice as student affairs professionals within higher education. Innovation has historically disrupted the shaping of higher education, and in many ways innovation is what those within higher education today are being asked to engage in through the accountability pressures they are experiencing (Cohen & Kisker, 2010; Schmidtlein & Berdahl, 2011). For example, pressure exists for institutions of higher education to meet the needs of increasingly diverse students, while also maintaining affordable costs. Innovating processes and practices within higher education is a way to respond to such pressures. Examples of disruptive innovation from the past include the credit hour and the academic calendar structure (Christensen & Eyring, 2011). More recently, advancements in technology are perhaps the most easily identifiable way the structure of higher education is being disrupted by an innovation (Straumsheim, 2013). The assignment for the course discussed in this article derived from a desire for students to become comfortable with incorporating the process of disruptive innovation into their practice so that they are prepared professionally for change within higher education.

Making It Work

Drawing associations between seemingly distinct processes can lead to innovative ideas that have the potential to disrupt the daily processes of higher education or any organization. The ability to associate is one of five skills identified as belonging to those who are disruptive innovators (Dyer, Gregersen, & Christensen, 2011). Association is connecting, “wildly different ideas, objects, services, technologies, and disciplines to dish up new and unusual innovations” (Dyer et al., 2011, p. 45). Thus, to help students strengthen their association skills so that they can bring innovation to higher education Pinterest was selected as a means for a biweekly assignment.

Pinterest “is a visual discovery tool that you can use to find ideas for all your projects and interests” (Pinterest, 2014). According to Popolo (2013), some of the most intriguing ways to use Pinterest include asking for donations, listing house rentals, raising awareness about various causes, and advertising casting calls, although the application is more commonly used for recipe sharing, photography, and crafting. Pinterest can be used privately or publically at an individual

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or community level, and is available at no cost to users globally. Essentially, Pinterest involves the process of creating virtual bulletin boards, known as “grub boards” to which users can pin resources and items of interest as “visual bookmarks” (Pinterest, 2014). Boards can be thematized, and multiple or singular users can contribute to their creation. Any item found on the Internet, including those pinned to others’ grub boards, or electronically created by the user, can be pinned and shared on one or more electronic grub boards. Users are also able to provide a 500-character description under each pin.

An account and online access is required to use Pinterest. Pinterest can be used to engage various populations around the globe (e.g., student affairs professionals) by following public boards and individual users. Users can also indicate interest in, or that they “like”, a pin by selecting a heart icon at the top of each pin, as well as comment underneath others’ pins. One example of an educator using Pinterest is Don Phelps (2014) who used Pinterest to create a board of “Books Worth Reading”. Another example is Karen Burns (2014) who created an “Ideas for HS Teachers” board to share technology applications designed to assist educators. Considering social media applications in general, Davis (2014) discusses the promising results of using applications, such as Pinterest, as learning tools by noting how they assist in teaching students how to communicate professionally online.

Process

Students were asked to create a Pinterest account, and establish a personal public board titled: “(Name) Innovating Student Affairs”. As the instructor, I followed each of their boards, and invited them to contribute to the class’s community board titled, “Innovating Student Affairs”. Biweekly, the students were to make five pins to their personal board, and then to make one unique pin on the class’s community board. Specifically, they were asked to make the following kinds of pins throughout the semester: quotes, news articles, videos, books, photos, blogs, and songs. For each pin, students were instructed to consider the week’s reading and class discussion topic, and pin items they saw as connected. The students were also required to describe the connections they saw in the description box underneath each pin, and to comment on the pins of their classmates. I reviewed all of their pins prior to class, and incorporated them into the class lesson plans.

Results

Students created their own boards, and contributed to the class board, which now serves as resources for the students as they transition into their new professional roles post graduation. The board is also a resource to users who followed the board from around the globe. Throughout the course of the semester, the class community board acquired over 115 followers, and many students indicated that they received new followers to their personal boards, as well as to their profile, because of their participation in the community board. Networking is a part of the job search process, and the students enrolled in the course were searching for their first post-graduation position. Thus, an unexpected benefit of using Pinterest was that it helped market students to those who followed the community and individual boards.

Students were evaluated on making their pins by the assignment deadline, adhering to the pin categories (e.g., quotes, videos, etc.), and the potential for their pins to contribute to the field of student affairs, which they were asked to describe in each pin's description box. Using Pinterest to explore disruptive innovation provided students:

- Opportunities to take quotes, videos, news articles, etc. of interest to them outside of higher education and seek associations between them and their work within higher education;
- The chance to explain to followers how making an innovative association can benefit their practice; and
- The chance to learn how to use a web-based technology application to engage with others on a global-level and as a resource to inform student affairs practice.

Future Implications

Going forward, using all the features within the Pinterest application has potential to broaden the use of Pinterest across educational levels and content areas. Pinterest provides a way for students to engage with others inside and outside of the classroom, while also creating an established resource connected to the course topic. Related to the use of Pinterest discussed previously, and based on the experiences students shared, I am currently incorporating several changes. Many students were unfamiliar with the application at the beginning of the semester, and although I encouraged them to experiment on the site in order to be comfortable with it, they were apprehensive. Thus, it took some time before providing descriptions, liking pins, and commenting on their peers' contributions became habitual. Also, I will ask students to advertise their boards to others in the field, in an effort to enhance their networking skills, as well as increase the number of connections to other Pinterest users who might find the boards useful. Finally, I will add to the assignment the task of finding a way to use the Pinterest application as a tool to innovate their practice, outside of the two boards required for class, so that trying out their ideas would add depth to the innovative skills they are developing.

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Popplet for Higher Education: Supporting Organization and Collaboration

Laura Corbin Frazier[1]

Keywords: Web 2.0, collaboration, graphic organizer, concept maps, Universal Design for Learning

Introduction

This article shares an innovative, technology-based approach to teaching using an old tool, the graphic organizer, in a web-based platform. Popplet is a Web 2.0 tool that allows users to quickly and simply create visually appealing graphic organizers that integrate text, image, video, and Internet resources to organize and present information. Popplet also supports collaboration as multiple users may develop a graphic organizer together and comment on each other's work. Strategies for using Popplet in higher education as a means of supporting Universal Design for Learning principles are provided.

Framework

In Foundations of Instructional Technology, a course in a Master of Education program with concentration in technology facilitation, an instructor integrated components of the Universal Design for Learning (UDL) framework and enhanced organizational support through the use of a web-based graphic organizer. The UDL framework calls for teachers to consider multiple means for representation of content, multiple means for students to demonstrate knowledge and multiple means for engagement and motivation in learning (CAST, 2013). Application of UDL framework principles in classrooms can enhance learning for a diverse range of learners; much as universal design in architecture (i.e., automatic opening doors, dropped curbs) has enhanced accessibility for a wide range of users (Rose & Meyer, 2002). UDL is regularly advocated in K-12 schools and has been encouraged in research literature for higher education.

Gradel and Edson (2009) endorsed the need for UDL in higher education citing the increased diversity of student learning needs in classrooms today as rationale for the need to provide multiple means to engage learners, represent content, and demonstrate knowledge. Further, they identified Web 2.0 tools as a prominent resource for educators as they seek to integrate UDL principles into their assignments and activities. In their work, Gradel and Edson (2009) provided an example of content mapping using a web-based graphic organizer and traditional note-taking as means for supporting the learning needs of students. Other research also supports the value of graphic organizers to facilitate student acquisition and organization of knowledge (Phillips & Nagy, 2014), enhance critical thinking skills (Atay & Karabacak, 2012), and foster improved planning and monitoring during inquiry activities (Hagemans, van der Meij, & de Jong, 2013).

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Making it Work

Previously, whiteboard and document camera/LCD projector were utilized to display graphic organizers created during class discussions. For example, a first day of class activity involved students in the development of a graphic organizer to represent the many and varied influences on teacher technology decision-making. In subsequent class sessions the graphic organizer was revisited and new influences on teacher technology decision-making were added based upon course content learning. This approach became problematic as the whiteboard needed to be erased at the end of each session and a paper document for use with the document camera became too cluttered with information. An interactive whiteboard may have remedied the situation, but one was not available in this classroom. The Web 2.0 tool, Popplet, offered features that would meet both course learning objectives and the physical constraints of the learning environment.

Popplet is freely available in a limited form at www.popplet.com or through the iTunes store as an iPad application. Reasonable subscription rates are available for the full feature version of the application which will allow for not only the development of graphic organizers, but also for the collaborative development of graphic organizers by multiple users. Both were employed in the foundations course.

Popplet is intuitive to use. Upon opening the application the user is prompted to make a Popplet through a clearly labeled button. A new workspace opens where Popples (what textboxes are called in Popplet) can be created to begin visually organizing and arranging information. Double clicking in the workspace creates a new Popple. Each Popple has design and formatting tools visible immediately upon creation. With these tools Popple color and size can be changed, drawing may be completed, and files (i.e., video, audio) may be uploaded. A comment box is also included with each Popple so that collaborators can comment on one another’s work. Popples may be connected simply by dragging a line from one Popple to another.

Initially, Popplet was used by the instructor to support the development of the aforementioned graphic organizer on influences to teacher technology decision-making. The tool was utilized by connecting an iPad (using HDMI cable adapter) to an LCD projector so that students could see the organizer displayed at the front of the classroom. Students were also able to add to the organizer by approaching the iPad at the front of the classroom. The graphic organizer was saved and used again in subsequent class sessions as a tool for organizing course content learning and as a platform for collaboration (Figure 1). Students were pleased with the ease and clarity of use for Popplet. During discussions, they expressed how helpful it was to have one place where course learning was summarized graphically, providing both visual and text-based organization. In this way the UDL principle for providing multiple means of representation of content was supporting the varied learning needs and styles of students. The initial success of this approach led to a subsequent use where students contributed individually using their own computing devices outside of the regular course meeting time.

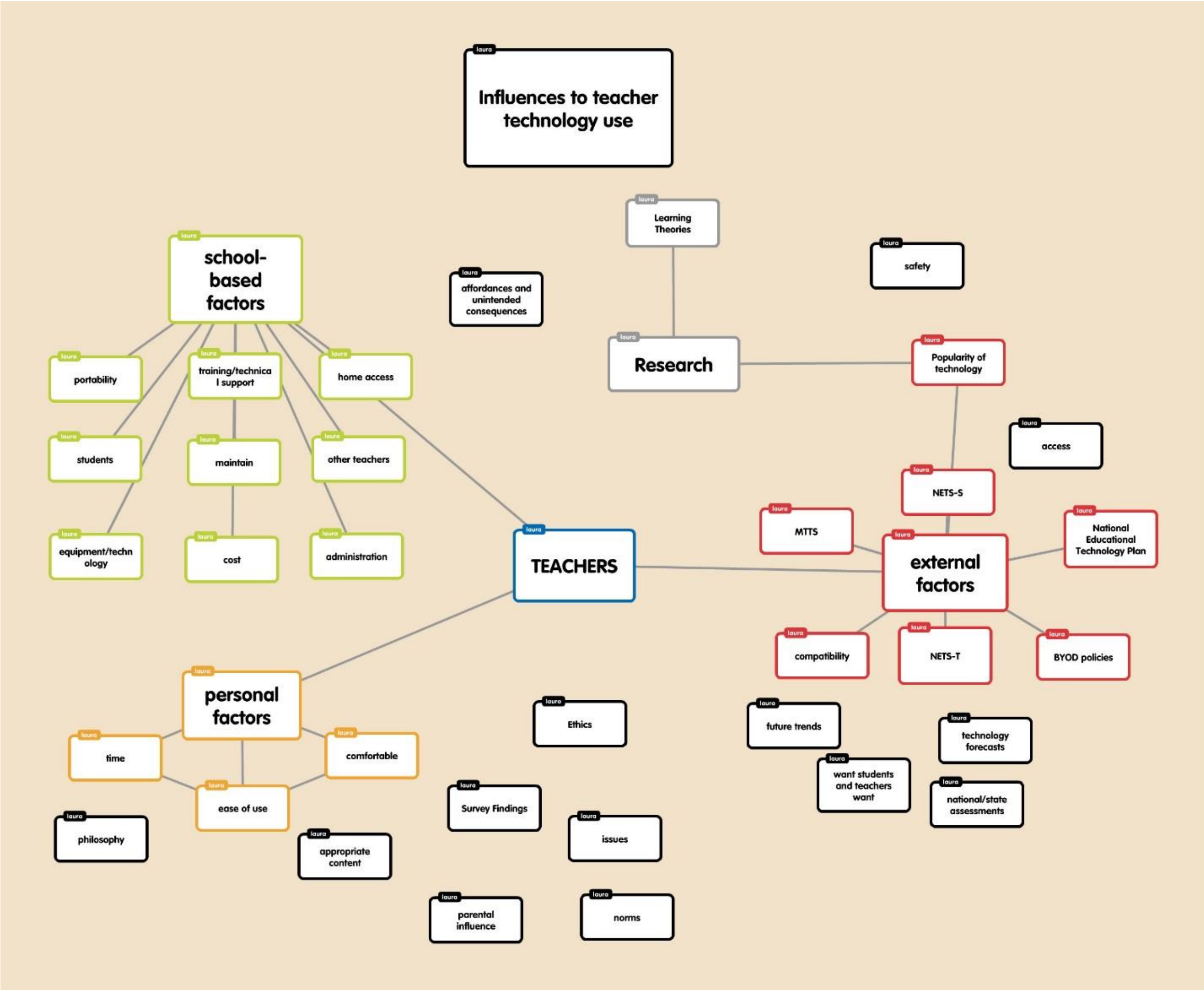

Figure 1. Influences on teacher technology decision-making. This figure illustrates how Popplet was used in a whole class face-to-face setting.

Multiple modules of study are presented in the foundations course. With each, Popplet was regularly utilized for organization and collaboration in both the whole class setting and in individual settings remote from the classroom. To begin the course, a common definition of technology was needed. After much discussion, consensus was reached on a definition. The definition needed to be placed in the context of classroom learning in order for students to fully understand the field of instructional technology, its origins and present status.

Popplet was utilized to help organize information through a technology timeline (Figure 2). Each of the eight students in the course were assigned a time period to research. They were to obtain a definition of technology/classroom technology from their assigned time period and to provide a few examples of classroom technology from the era. Using collaborative features in Popplet the instructor was able to add collaborators via email invitation. Then, each student had editing access to the class Popplet and was able to add their research in a new Popple below their assigned time period. Subsequent class discussion followed.

Later in the course, learning theory, instructional paradigms, and conceptual frameworks were introduced. Again students shared their knowledge by placing this information on the timeline below the appropriate time period from its origin or prevalence in use. In the subsequent class session this supported dialogue by looking at the types of technologies that were in use in classrooms when certain instructional approaches were prevalent. For example, through Popplet observations, students noted the use of drill and practice software aligned with Behaviorism. Next, students learned of prominent figures in the field (e.g., Papert) and seminal research (e.g., Apple Classrooms for Tomorrow) and again placed these on the graphic organizer timeline. This process continued throughout the duration of the course. In this way multiple means for representing information were provided by the instructor, students were able to express their knowledge in this digital platform (as well as through other traditional classroom assignments and activities), and students were motivated to learn by their use of Popplet as a means for collaboration and as a means for visual representation of content.

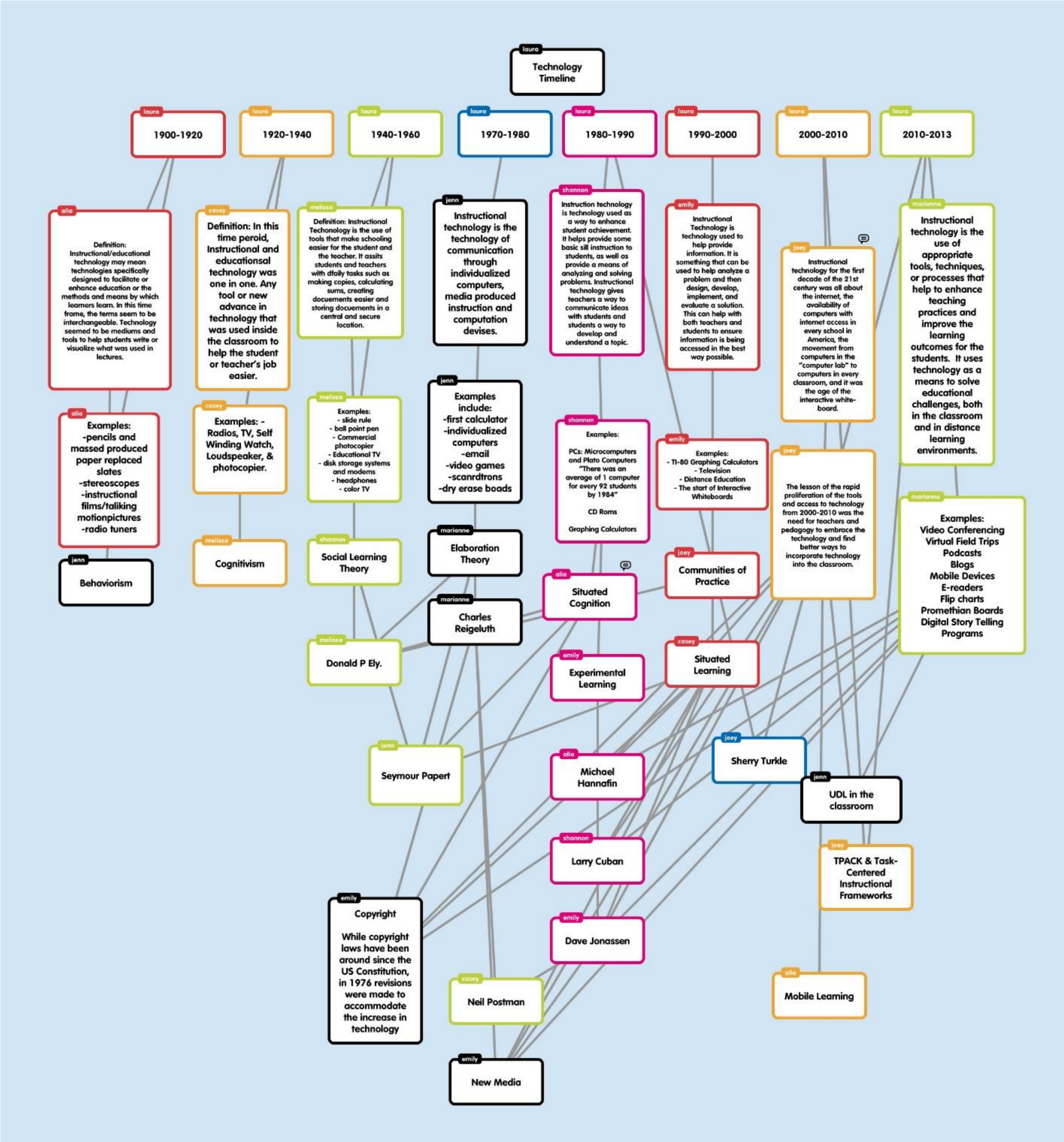

Figure 2. Technology timeline. This figure illustrates how Popplet was used by students to create a timeline.

Utilizing Popplet as a means to incorporate UDL principles into higher education coursework was effective in organizing course content and also supported technology-assisted management of learning. As a note, the instructor subsequently utilized Popplet with a faculty colleague while discussing/organizing research data too.

Future Implications

The relevance of this technology-enabled approach to teaching in higher education lies in its simplicity. Instructors are familiar with graphic organizers, the pedagogical approach described is not dependent on any specialized training or professional development, and no software needs to be installed to begin use of Popplet. As a Web 2.0 tool facilitating research-based best practices, Popplet, supports the integration of technology into instruction to enhance organization of content, to engage learners through collaboration, and to provide an innovative analysis and feedback method for students.

This is an innovative approach for use in higher education as traditional graphic organizers are fixed, static documents. With Popplet, students and instructor can easily discuss and move ideas within their popples. They can add media-based examples to further clarify meaning and they can do all of these things in both face-to-face and online settings. A feature that is especially helpful in the online setting is the ability for students/instructor to post comments and questions directly to a popple. In this way collaboration is enhanced and dialogue is further organized given the direct connection to a specific popple/content topic.

The features of Popplet support instructor/peer feedback and collaboration. This benefits learners as they are provided multiple perspectives on content and challenged to make meaning in new ways. Similarly, through the graphical interface some learners may be challenged to present their learning in new ways; while other learners may benefit from the opportunity to have content presented using multiple means for representation.

Given the initial successes with Popplet, instructor continued use is likely in the future. However, it should be noted that small class size may have played a role in the successful implementations described. Given a larger class size (i.e., greater than 10), the Popplet tasks may have become too cluttered or overlap of student generated content may have become repetitive. In such cases, students may need to be divided into groups of no larger than eight. Popplet is not content dependent and could be successfully used to support varied learning needs, foster critical thinking, and enhance organization and management of course content. An instructional modification may include the use of AirServer (available at www.airserver.com) as a means of untethering the iPad (or any mobile device) from cables connecting to a projector. This would allow for convenient passing of the device from student to student, while still projecting the Popplet at the front of the classroom for ease in visibility by all.

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Book Review

The New Digital Shoreline: How Web 2.0 and Millennials are Revolutionizing Higher Education

Wendy Kraglund-Gauthier[1]

Citation: Roger McHaney. (2011). *The New Digital Shoreline: How Web 2.0 and Millennials are Revolutionizing Higher Education*. Sterling, VA: Stylus.

Publisher's Description: *Two seismic forces beyond our control – the advent of Web 2.0 and the inexorable influx of tech-savvy Millennials on campus – are shaping what Roger McHaney calls "The New Digital Shoreline" of higher education. Failure to chart its contours, and adapt, poses a major threat to higher education as we know it.*

These forces demand that we as educators reconsider the learning theories, pedagogies, and practices on which we have depended, and modify our interactions with students and peers—all without sacrificing good teaching, or lowering standards, to improve student outcomes.

Achieving these goals requires understanding how the indigenous population of this new shoreline is different. These students aren't necessarily smarter or technologically superior, but they do have different expectations. Their approaches to learning are shaped by social networking and other forms of convenient, computer-enabled and mobile communication devices; by instant access to an over-abundance of information; by technologies that have conferred the ability to personalize and customize their world to a degree never seen before; and by time-shifting and time-slicing.

As well as understanding students' assumptions and expectations, we have no option but to familiarize ourselves with the characteristics and applications of Web 2.0—essentially a new mind set about how to use Internet technologies around the concepts of social computing, social media, content sharing, filtering, and user experience.

Roger McHaney not only deftly analyzes how Web 2.0 is shaping the attitudes and motivations of today's students, but guides us through the topography of existing and emerging digital media, environments, applications, platforms and devices – not least the impact of e-readers and tablets on the future of the textbook – and the potential they have for disrupting teacher-student relationships; and, if appropriately used, for engaging students in their learning.

This book argues for nothing less than a reinvention of higher education to meet these new realities. Just adding technology to our teaching practices will not suffice. McHaney calls for a complete rethinking of our practice of teaching to meet the needs of this emerging world and envisioning ourselves as connected, co-learners with our students.

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In *The New Digital Shoreline: How Web 2.0 and Millennials are Revolutionizing Higher Education*, author Roger McHaney presents an accessible and user-friendly account of how to approach technology and digital learning in the 21st century. In an easy-to-read tone, McHaney outlines how an explosion of affordable technological devices and applications has the power to disrupt the way higher education delivers learning and how students access that learning.

Taking up the collective perception of today's students as digital natives, McHaney sketches out broad descriptions of millennials as a generation of socially networked, computer-enabled individuals. Although McHaney's characterization of millennials as impatient and self-absorbed is negative and stereotypical, it does serve to underscore the idea that the majority of the students in today's higher education classes are accustomed to immediate answers, thrive in social settings, and expect to have input into the design of their physical and virtual learning environments. Their expectations for personalized learning experiences often stand in stark contrast with what actually happens in many higher education classrooms, often because of, as McHaney admits, the inadequate training with technological tools and their instructors' skills and knowledge in pedagogical practices that integrate those tools.

Despite significant challenges in coordinating users' experience with Web 2.0 features because of rapid evolutions of technology and how quickly applications move in and out of vogue, McHaney's detailed chapters on interactive devices, tools for content development and delivery, gaming as learning strategies, mobile devices, social media, and virtual learning environments serve as useful foundations on which to build a technology repertoire. Before reading these chapters, however, some readers will benefit from sailing over to Chapter 7: Convergence in the New Shore and reading descriptions of several adult learning theories first. This should help to anchor the reader's consideration of pedagogy in terms of philosophical beliefs about teaching and learning before getting swept away in the oceans of technological possibilities that McHaney has shared.

By harnessing the power of the typical millennial student's connection to data-rich networks of peers and information, instructional strategies and learning activities—both in and outside the classroom and regardless of geography—become relevant, engaging, and responsive. The advice for instructors to "update their knowledge and be able to communicate within the world their tech savvy students inhabit" (p. 194) is a key take-away. Something McHaney does not reiterate enough is security of sensitive information and the importance of holding learning outcomes at the forefront of pedagogical planning rather than the implementation of the technological tool. As well, a frank and realistic discussion of Web 2.0 technologies in terms of privacy, equitable access to technology, Internet access, and appropriate use is warranted. Another important detail that McHanley glosses over is the disparity between instructors' pedagogical skill sets in terms of teaching and assessment. When new technologies are introduced into teaching and learning practices, productivity decreases as users climb the learning curve.

Higher education still has some barriers to overcome before providing an authentic, seamless learning experience that incorporates Web 2.0 technologies. Web 2.0 technology and applications cannot be successful in isolation. In order to function and thrive in the 21st century, all levels of higher education will need to accept and leverage Web 2.0 technologies to transform the way they engage with potential and current students and how they innovate in product (i.e., education) and service delivery. An engaging instructor and effective curriculum design with inspiring content are vital criteria for a successful learning program in higher education. Despite its limitations, this text is a valuable navigational tool.

JoTLT
Journal of Teaching and Learning with Technology

Mission

The Journal of Teaching and Learning with Technology (JoTLT) is an international journal dedicated to exploring efforts to enhance student learning in higher education through the use of technology. The goal of this journal is to provide a platform for academicians all over the world to promote, share, and discuss what does and does not work when using technology in postsecondary instruction. Over the last few decades, faculty have progressively added more and more sophisticated technology into their courses. Today, the variety of technology and the creative ways in which technology is being used is simply astonishing, whether in-class, online, or in a blended format. In the final analysis, however, it isn't whether our students - or faculty members - like the technology that matters but whether the addition of these technological tools results in or expands access to quality student learning. JoTLT will play a prominent role in helping higher education professionals better understand and answer these questions.

We will accept four types of manuscripts:

Quick Hits: A Quick Hit is a brief contribution describing innovative procedures, courses, or materials involving technology (1500 words or less). Each contribution should include sufficient detail to allow another educator to use the Quick Hit in his or her own course.

Empirical Manuscript: Manuscripts in this category should provide qualitative or quantitative evidence demonstrating the effectiveness of the technology in increasing student learning. Each manuscript should include sufficient detail to allow another educator to use the technology in his or her own course.

Book Reviews: Book Reviews can be submitted for recently published works related to teaching and learning with technology. These manuscripts are typically less than 1500 words in addition to the complete citation of the book and the publisher's description of the book.

Case Studies: These studies illustrate the use of technology in regards to teaching and learning of higher education students, usually generalizable to a wide and multidisciplinary audience.

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Style Sheet for the *Journal of Teaching and Learning with Technology*

John Dewey[1] and Marie Curie[2]

Abstract: This paper provides the style sheet for the Journal of Teaching and Learning with Technology. Manuscripts submitted for publication should adhere to these guidelines.

Keywords: radiation, metacognition, identity theory, constructivism, educational philosophy.

General Guidelines for the Manuscript

Submissions should be double-spaced. The final manuscript should be prepared in 12-point, Times New Roman, and single-spaced. All margins should be 1 inch. Justify lines; that is, use the word-processing feature that adjusts spacing between words to make all lines the same length (flush with the margins). Do not divide words at the end of a line, and do not use the hyphenation function to break words at the ends of lines. The title (in 16 point bold) and author's name (in 12 pt. bold) should be at the top of the first page. The author's name should be followed by a footnote reference that provides the author's institutional affiliation and address. Please use the footnote function of your word processing program; there are a variety of instructions available online for each program. The abstract should be indented 0.5" left and right from the margins, and should be in italics.

Indent the first line of every paragraph and the first line of every footnote; all first line indentations should be 0.5". Use only one space after the period of a sentence (word processors automatically adjust for the additional character spacing between sentences). The keywords should be formatted identically to the abstract with one line space between the abstract and the keywords. Authors should use keywords that are helpful in the description of their articles. Common words found in the journal name or their title article are not helpful keywords.

Pages should be unnumbered since they will be entered by the JoTLT editorial staff. We will also insert a header on the first page of the article, as above.

References should be incorporated in the text as author's name and date of publication (Coffin, 1993), with a reference section at the end of the manuscript (see below for the desired format for the references). Titles of articles should be included in the references in sentence case. Unless instructed otherwise in this Style Sheet, please use APA style formatting. Footnotes should incorporate material that is relevant, but not in the main text.

Plagiarism

It is essential that authors refrain from plagiarism. Plagiarism is a violation of ethics and, in serious cases, will lead to a manuscript being rejected by this journal. No future manuscripts will be accepted from authors who have submitted a plagiarized manuscript.

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Major section headings should be centered and bold-faced (i.e., Section and Sub-Section Headings as seen above). Major section headings should have one-line space before and after. The first paragraph(s) of the article do not require a major heading.

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Sub-section headings should also be flush-left and bold-faced. Sub-section headings should have a one-line space before and after. Sub-sub-sections should appear at the beginning of a paragraph (i.e., with an 0.5" indent, followed immediately by the text of the sub-sub-section), with the heading also in italics.

Sub-subsections. Sub-Subsections of your manuscript should be formatted like this.

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Tables and figures should be inserted in the text where the author believes they best fit. They may be moved around a little to better correspond to the space requirements of the Journal. If necessary, tables and figures may occupy an entire page to ensure readability and may be in either portrait or landscape orientation. Insofar as possible, tables should fit onto a single page. All tables and figures should be germane to the paper. Tables should be labeled as follows with the title at the beginning, with data entries single-spaced and numbered. Column labels should be half-line spacing above data. Please use the table functionality in your word-processing program rather than adding an image of a table from MS Excel, SPSS, etc. This allows for more flexibility in laying out the final print version.

Table 1

The title of the table

Unit	**Length, inches**
Point	1/12
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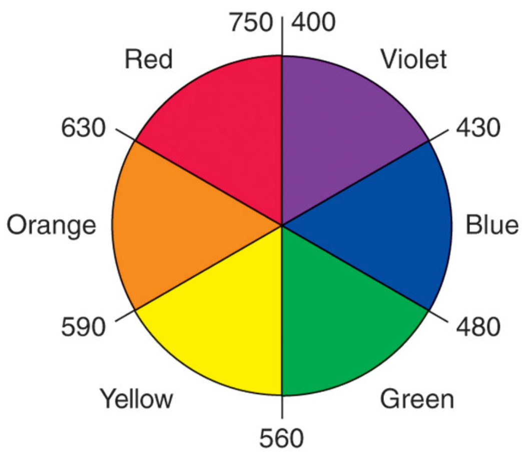

Figure 1. Color wheel with wavelengths indicated in millimicrons. Opposite colors are complementary.

Acknowledgements

Acknowledgements should identify grants or other financial support for this research by agency (source) and number (if appropriate). You may also acknowledge colleagues that have played a significant role in this research.

Appendix

Please insert any appendices after the acknowledgments. If your submission has only one appendix, this section should be labeled '*Appendix.*' More than one appendix will change the section label to '*Appendices.*' Each appendix should have a title; if you are including items from your class or research, please alter them to include a title. Appendices should be alpha-order (Appendix A, Appendix B, etc.) These labels and titles should be at the top of the page, left justified, italicized.

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The content of your appendix will appear here.

References

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