Innovation Centers and the Information Schools: The Influence of LIS Faculty

Paul Marty, *School of Information, Florida State University.*
marty@fsu.edu
Rienne Saludo, *School of Information, Florida State University.*
ren@innovation.fsu.edu
Castle U-Seong Kim, *School of Information, Florida State University.*
udk16@my.fsu.edu

As universities worldwide develop centers for innovation intended to encourage a culture of technological innovation among their students, what role should LIS faculty play? What is the relationship between technological innovation and LIS education? How can LIS educators help students develop their ability to innovate with emerging technologies? This article presents a case study of an undergraduate course offered by the School of Information at Florida State University that brought together students from different majors in a custom-built innovation classroom simulating the innovation centers that many universities are creating for their students. It evaluates a teaching philosophy that offered students ownership over the structure of the semester, safe opportunities to take risks, and the opportunity to solve real-life problems with technology. The results document the connections between innovation centers and the information schools and show how LIS faculty can influence the development of innovation centers on campus.

Keywords: emerging technologies, higher education, innovation centers, LIS education, technological innovation

This article focuses on a deceptively simple question: what does it mean for universities to promote technological innovation among their students, and how can Library and Information Science (LIS) faculty play a role in that process? Despite the long-standing relationships that exist between technological innovation and information science (e.g., Barron, 2003), LIS faculty are not often considered technological innovators. Therefore, as universities around the world develop centers and create programs specifically intended to encourage innovation with technology, it is imperative that LIS educators step forward to offer courses, design curricula, and contribute their expertise in support of these efforts. But how do we do that? Who is helping university faculty, staff, students, and administrators understand the important connections between innovation centers and the information schools? Who is responsible for bridging the gap, perceived or actual, between LIS education and technological innovation?

It is our contention that LIS faculty are uniquely positioned to guide universities as they promote innovation and technology on their campuses. The growing emphasis on technological innovation in higher education makes it essential that the information schools examine what they can learn from this trend and demonstrate what they can bring to this process. To improve our understanding of how LIS faculty can help students develop their ability to innovate with technology in conjunction with efforts happening at the university level, this article presents a case study of an undergraduate course taught by faculty in the School of Information at Florida State University (FSU) that focused on teaching students from all majors how to innovate with emerging technologies in a specially designed innovation classroom. The results of this research offer one example of how a strong relationship can be built between the information schools and technological innovation, and they illustrate one way in which LIS faculty can influence the design and development of innovation centers on campus.

KEY POINTS:

- LIS faculty can influence the design and development of innovation centers at universities by emphasizing the strong historical relationship between the information schools and technological innovation.
- LIS faculty can encourage technological innovation in their classrooms and help their universities promote learning by inspiring university students to get involved with emerging technologies.
- LIS faculty can leverage their knowledge, skills, and experiences to transform our shared understanding of what it means for universities to encourage students to innovate with technology and to build a culture of innovation on campus.

Background

New understandings of best practices for encouraging technological innovation have prompted administrators at many universities to create interactive spaces where students can gain experience innovating with technology (Halverson & Sheridan, 2014; Wong & Partridge, 2016). Similar developments have simultaneously prompted LIS educators to take a closer look at the potential value of makerspaces and innovation centers for their students (Bowler, 2014; Koh & Abbas, 2015; Mills, Campana, & Goldsmith, 2017). To provide a useful background for understanding this changing environment, this section explores the role of technological innovation in higher education, the changing nature of technological innovation for university students, and the relationship between technological innovation and the information schools.

Technological innovation and higher education

What does it mean for a university to innovate with technology? This is a large and complex question because technological innovation in higher education runs the gamut from curricular enhancements to infrastructural improvements. Innovation, writ large, is a very broad concept. The economist Joseph Schumpeter (1947, p. 151) defined innovation as "simply the doing of new things or the doing of things that are already being done in a new way."

This is by necessity a very broad definition, and therefore, for the purposes of this study, it is instructive to examine one specific technological innovation that, for a period of time, was popular with LIS educators: Second Life, a multi-user virtual environment in which individual users assume the personas of virtual avatars and interact with each other in a virtual world. During its heyday in the mid-2000s, Second Life was frequently hailed as the future of virtual reality for higher education (Warburton, 2009). As part of their ongoing engagement with technological innovation, many LIS programs decided to explore Second Life and its affordances for education, creating new virtual learning environments for their students and new research opportunities for their faculty (Cote, Kraemer, Nahl, & Ashford, 2012; Luo & Kemp, 2008).

The FSU School of Information built its first virtual campus in Second Life in 2004, investing significant time and energy in this process. We surveyed students, talked with faculty, performed environmental scans, and observed what was working (or not working) elsewhere in an attempt to provide features that would meet the needs of our user community. We had instructors teaching classes and holding office hours in Second Life. We had students learning about virtual reality and building interactives in world. We even held convocation and graduation ceremonies there for our distance students. Yet today, like the majority of the virtual environments that universities created in Second Life (Mark, 2014), our Second Life island is long since abandoned.

Like any enterprise engaged in constant innovation as part of its core mission, the School of Information found that Second Life was one of those technologies whose long-terms costs outweighed its utility for teaching and research. Yet the lessons we learned from incorporating this new technology into our student and faculty experiences provide a valuable perspective on the challenges we face when universities innovate with technology. Whether one is building a virtual campus in Second Life or an innovation center in real life, the space is less important than the people. Without a steady stream of involved participants and engaging activities, interactive spaces cannot succeed. The challenges of technological innovation in education lie more with creating a culture than with creating a space (Kim, Edouard, Alderfer, & Smith, 2018). And what makes this particularly difficult is that not only do the technologies we use to innovate keep changing, but our attitudes and perceptions about what it means to innovate with technology keep changing as well.

Technological innovation and university students

For many LIS educators, their experiences with innovative technologies when they were students looked very different from the lived experiences of their students today. One of the difficult challenges facing LIS educators, therefore, lies in finding ways to bridge an ever-widening gap that reflects not just those experiential differences but also changing philosophies about what it means to innovate with technology in the first place. Broadly speaking, technological innovation provides individuals with "the increased capacity . . . to do what they want and need to do in a way that most benefits their productivity, pleasure, and excellence" (Deiss, 2004, p. 19).

This is also a very broad definition, and therefore, for the purposes of this study, it is useful to examine how universities teach computer programming as a specific example of this changing philosophy (Florez et al., 2017). The days in which old-school programmers typed commands on blank screens or filled out punch cards are long gone. Modern software development is more about importing and adapting code that someone else has already written than it is about writing new code entirely from scratch. Students today are increasingly in a situation where many of the tools they need to complete their projects already exist, and their task is to find the correct building blocks, and put them together in new, creative ways.

When it comes to helping students understand how to innovate with technology, this building-block culture offers tremendous advantages. Every year, the barrier that students have to get over to innovate with technology gets lower, and their reward for getting over that barrier gets larger. Not long ago, for example, if one wanted to teach students how to make a blog, one would have to build most of the technology oneself, including much of the hardware. Today, if students want a blog, they can visit any number of websites and start blogging immediately. And if they are dissatisfied with the options available to them online, they can download the source code for free and install it on a server they control, designing their blog however they want.

There is a freedom to innovate here that even 20 years ago would have been difficult to imagine, and as a result, universities are encouraging students to pursue careers focused on innovation and design, investing their resources in building makerspaces and innovation centers and offering new programs centered on emerging technologies (Barrett et al., 2015). This freedom to innovate also represents a change in mindset that can be difficult to internalize, and even potentially dangerous, if students do not learn how to innovate with technology responsibly and safely. Who is teaching students how to thrive in an environment where innovation means finding bits and pieces of technology that other people have already made, and putting them together to make something new? Who is preparing students for the difficult task of innovating with technology in a complex environment where what it means to innovate constantly changes? It is

our belief that the information schools can and must play that role with respect to technological innovation and university students.

Technological innovation and the information schools

As universities promote technological innovation on campus, it is imperative that LIS educators develop methods for teaching students how to innovate with technology such that they understand not only how new technologies are created but also that in the long run, learning how to use technology is easy, but figuring out what to do with it is hard. At times this can seem like an uphill battle. Anyone who has tried to explain to an incredulous audience that LIS faculty have been teaching online for more than 20 years, and have been pioneers in distance education for more than a century (Barron, 2003), knows that one of the problems with being on the cutting edge is that sometimes you're so far ahead, you're behind.

There has long been a close relationship between LIS education and technological innovation. According to the American Library Association, students in LIS programs should be able to employ the "principles and techniques necessary to identify and analyze emerging technologies and innovations in order to recognize and implement relevant technological improvements" (American Library Association, 2009). Recent research by LIS faculty members has extended these competencies to cover information professionals teaching and learning with innovative technologies in makerspaces and learning labs (Koh & Abbas, 2015).

Despite this relationship, faculty and staff unfamiliar with the history of LIS education and technological innovation may not see the information schools as playing an important role in the development of innovation centers on campus. Yet it is the constantly changing nature of what it means to innovate with technology that makes the information sciences so ideally suited to guide universities as they promote technological innovation among their students, precisely because the information sciences, as a meta-discipline (Bates, 1999, 2015), are primarily concerned not with the *what* or the *who*, but with the *how* and the *why*.

When one considers, for example, the lessons that LIS faculty learned from Second Life, one sees that despite the lack of lasting implementations, these experiments were not failures but valuable opportunities to learn from exploring new technologies. The reason to invest time in a space like Second Life is not to build something that will last forever but to develop expertise and familiarity with emerging technologies; indeed, this form of learning is the most important outcome when testing any new technology. When you live on the cutting edge of technological innovation, what you accomplish does not matter so much as what you learn from the process, because what you seek are the intangible outcomes of your work.

What makes this especially challenging for educators, however, is that teaching students the value of experimenting with technological

innovation, whether one succeeds or fails, let alone the importance of the intangible lessons one learns from those experiments, is far more difficult than simply teaching students technology. How do we teach students that learning to use technology is easy, but learning *from* their use of technology is hard? How do we create a culture of engagement with technological innovation where what matters is not whether students succeed or fail, but what they learn from the process?

Methods

These were important questions for us to answer, because at the time of our research, Florida State University was working on plans for a brand new, university-wide innovation center intended to promote a culture of innovation, creativity, and entrepreneurship across campus. As our university moved forward with creating this new space, we knew that educators would need new methods of teaching students how to innovate with technology. We wondered, therefore, if we could implement in a classroom environment the kind of innovation activities that universities want to see happen in their innovation centers. And if we did that, could we answer important questions about the ability of LIS faculty to influence the development of innovation centers on campus?

Research setting

Our first step was to create an "innovation classroom" that would provide a microcosm of the environment envisioned for FSU's proposed innovation center: an open space featuring emerging technologies, a wide variety of people sharing their expertise, high levels of interactivity and energy, and most important, students from different majors working together on shared projects. Our plan was to offer classes that would help students from all over campus to employ emerging technologies to solve complex problems—classes that would bridge the gap between traditional courses teaching specific technology skills and the kind of open-ended, extracurricular activities that universities intend for their innovation centers.

In fall 2015, the FSU School of Information opened an experimental space called the "Collaboratory," a 20-by-30–foot room filled with innovative technologies for students to use: virtual reality headsets, 3D printers and scanners, minicomputers like Raspberry Pi, and so on. But if students are going to innovate, access to technology is not enough; there has to be a shared culture of engagement with innovation. To experiment with different approaches of encouraging that culture in a university setting, we developed a class where students worked with the emerging technologies available to them in the Collaboratory to accomplish a shared goal.

In spring 2016 and spring 2017, we offered a special topics course on "Exploring Emerging Technologies" open to undergraduate students from any major who wanted to experiment with using emerging technologies to solve problems in a goal-based, project-oriented environment.

Our Emerging Technologies course was offered as part of a new initiative at FSU to involve students in interdisciplinary, hands-on, project-based classes, and as a result, this provided a unique opportunity for us to attract a wide range of students from across campus.

Rather than teaching students how to use the various technologies available in the Collaboratory through a series of unconnected instructional modules (how to build a computer, how to fly a drone, how to use 3D printers, etc.), our focus was on providing an intellectually stimulating challenge that would tie together the available technologies into a coherent whole: a class where students learn that their ultimate goal is not the management of technology but the creative use of it. We wanted to see what would happen if we used an overarching, possibly even audacious, goal to provide our students with a shared purpose and sense of autonomy in a way that simulated the process of technological innovation writ large and shed light on the potential for LIS faculty to influence the design and development of university innovation centers.

Research questions

We proceeded with the assumption that by studying an approach to teaching innovation where we set the students a challenge, showed them how to use the tools at their disposal, provided ready access to experts who could point them in the right direction, and then got out of their way, we could learn valuable lessons that would help all students innovate successfully as more universities build their own centers for innovation and design. After all, a common feature of these centers is that they are supposed to be student-driven (Barrett et al., 2015), with a variety of student-led initiatives, and as a result, new philosophies will be needed to help ensure those initiatives are successful.

To evaluate our teaching philosophy for teaching innovation, one that focused on giving students ownership over the structure of the semester, safe opportunities to take risks, and the chance to work together to solve real-life problems, we asked two research questions:

1. How can a problem-based, goal-oriented approach to teaching innovation, where students are set a challenge and encouraged to find their own solutions, engage and inspire students to acquire hands-on experience with emerging technologies?
2. How can access to learning in an innovation classroom, where students have a safe space to experiment with technologies and design innovative solutions to challenging problems, help students become more involved with technological innovation?

In asking these questions, we were guided by theoretical concepts drawn from research in inquiry-based learning (Barell, 2007), creative inquiry (Montuori, 2012), active learning (Bonwell & Eison, 1991), and practice-based learning (Ball, 2008; Huggins, 2017). We were particularly

inspired by the "Hanging Out, Messing Around, Geeking Out" approach to involving young people with digital media (Ito et al., 2009), and sought to replicate this philosophy in our course, our classroom experience, and our methods of interacting with students.

Research data

To answer our research questions, we collected and analyzed data from the spring 2016 and spring 2017 iterations of our Emerging Technologies class. Each iteration of the class was taught to 25 undergraduate students, all members of the University's Honors Program, for a total of 50 students across the two iterations. There were 29 male and 21 female students enrolled in the course, including seven Freshmen, 25 Sophomores, 16 Juniors, and two Seniors. More than 30 different programs from across campus were represented, including such majors as biology, psychology, mechanical engineering, chemistry, finance, exercise science, public relations, computer science, meteorology, nursing, political science, and studio art. Each student was eager to acquire hands-on experience working with emerging technologies.

Each time we taught the course, we employed a reflexive pedagogy approach (Cunliffe, 2009), where students and instructors regularly reflected on what they had accomplished and what they had learned at distinct time intervals (daily, weekly, monthly, and at the end of the semester), and recorded their reflections through different media (blog posts, group updates, and individual written reports). As a result, we generated extensive reflexive documentation about what worked in the classroom and what the students learned from our approach to teaching technological innovation. We used these resources to document the history of the course, creating a record what the students accomplished each time the course was taught, and what students and instructors learned about innovation and technology from participating in the class.

To understand how we structured the course for the students, for example, we studied our course syllabi, weekly outlines, and assignment descriptions[1] and examined our notes from the time we spent designing each course to clarify our approach to scaffolding student learning and encouraging student success. We used these sources to document reflexively the overarching goals we presented to the students each semester, why we picked those goals, and how we structured the course to guide the students through the process of working with the emerging technologies necessary for them to meet their goals.

We examined a wide variety of detailed reports collected as part of the day-to-day operations of the course, including daily in-class documentation of student activities (photos, videos, whiteboard captures, student artifacts, instructor notes, etc.), weekly blog postings (written by the instructors, and posted online to document the students' progress each week), and monthly student progress reports (submitted by student groups three

times each semester).[2] We used these documents, along with our own observations of the students in each class session, to analyze reflexively what the students accomplished each semester, and how they kept each part of the project moving forward.

We assessed individual student self-assessments of their own learning outcomes (two reports from each student each semester), student course evaluation data (including open-ended and closed-ended responses from the university's official course evaluations, as well as informal feedback from students in and out of class), and the official project outcomes (including student-produced behind-the-scenes videos documenting what they accomplished and what they learned from the course).[3] We used these sources to determine reflexively what the students learned about emerging technologies, collaboration, and innovation each semester.

The results of our reflexive pedagogical analysis shed light on our educational practices across each semester (Hara, 2010). The extensive reflexive documentation gathered from instructors and students allowed us to identify the factors that influenced the students' ability to achieve their goals, experiment with technology, and design their own solutions to problems, as well as those that influenced our ability to create an environment where students would have the autonomy and the confidence to innovate with emerging technologies successfully. By carefully evaluating the historical documents that we gathered over the course of each semester, and using each data source to provide its own unique insight into our educational practices, we were able to better understand the potential of our teaching philosophy to engage students with emerging technologies in the classroom, as well as the ability of LIS educators to encourage technological innovation among university students.

Findings

The results of our research demonstrate how LIS faculty can take advantage of the increased focus on technological innovation and the creation of innovation centers at universities to help students become comfortable working with emerging technologies as part of their curricula. Drawing on the research data identified above, this section explores how we scaffolded the course and worked with the students to improve their chances for success, what the students accomplished during the class sessions each semester, and what the students learned about emerging technologies and technological innovation from their experiences.

Scaffolding for student success

Our analysis of course syllabi and planning documents provided valuable details about how we structured the Emerging Technologies class to give the students autonomy in figuring out their own solutions without overwhelming them with the magnitude of the task they faced. It was important that the students faced challenging tasks, but not impossible ones. Our solution was to scaffold their activities over the course of the

semester into several distinct phases (Introduction, Explore, Design, Deploy, and Deliver), divide the students into teams at various points along those phases, and chunk each task into separate feasible, approachable, and manageable steps.

In advertising the class, we told potential students nothing about our plans, what we were going to ask them to do, or how much autonomy they would have. During the first class session, we gathered the students together in the Collaboratory and laid out their overarching goals for the semester. In spring 2016, we told the students that their goal was to launch a 3D-printed copy of the three torches found on FSU's official seal into the upper atmosphere on a weather balloon, using cameras to capture a 360-degree video of the torches floating as high as possible above the earth. In spring 2017, we told the students that their goal was to coordinate a flash mob, involving as many students from across campus as possible, standing in the shape of a giant torch stretching from one end of FSU's main quad (Landis Green) to the other, while flying drones captured the entire event from the sky. Each of these goals was something that had never before been done at FSU, and we selected them because we needed them to be compelling, something that would engage the students and inspire them to get involved in and out of class.

Each semester was only 15 weeks long, and it was important that the students remained on task as they worked on their projects. After the introductory week, where the students learned the nature of the task facing them and how the course would work, the students then spent several weeks in a structured environment exploring the technologies they would need to use to complete their tasks in small groups. These groups were randomly assigned, so that students from different majors would have the chance to collaborate with a range of students from across campus. At the end of each week, the groups submitted notes describing how they might use these technologies to meet the overarching goal.

At the end of this exploration phase, each student handed in their first self-assessment, discussing what they had learned so far and explaining the issues and technologies that interested them. We used these self-assessments to divide the students into formal groups of approximately five students each, which then spent several weeks designing their ideas (followed by a group progress report), and several more weeks prototyping and testing their ideas (followed by a second group progress report). At this point, fourth-fifths of the way through the semester, they implemented their ideas and saw what happened. The students then spent the last few weeks of class creating their final deliverables, including class videos, final group project reports, and their second individual self-assessments.

Each of these phases is detailed in the following section for both the spring 2016 and spring 2017 semesters; Figure 1 shows a weekly progress chart from the spring 2016 semester, including five weeks of group exploration notes, three group progress reports, two individual self-assessments, and the "launch" at the end of Week 12.

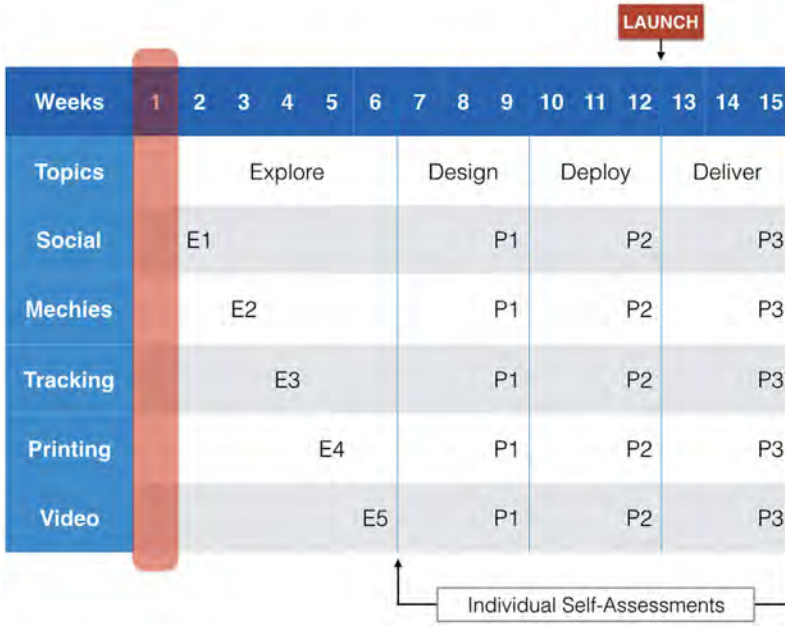

Figure 1: Weekly progress chart for spring 2016 (five topics and five phases over a 15-week semester)

Lighting the torch of innovation

Our analysis of daily class notes, weekly blog postings, and monthly group progress reports provided vivid details about what happened during each phase (Introduction, Explore, Design, Deploy, and Deliver) of the two iterations of our Emerging Technologies class. Space constraints make it impossible to provide extensive details for each phase, but highlights from each iteration are presented.[4] This section draws upon these historical materials to document how we encouraged the students to innovate with technology, what the students were able to accomplish in each phase, and how we organized the class around their individual and group activities.

Each semester began with an introductory week to engage and inspire the students, introduce them to that semester's overarching goal, and discuss the nature of technological innovation. We used this week to lay out the challenge for the students and present our teaching philosophy. We needed them to understand that this was not the kind of class where we taught them something and they learned it, but one where they would have the chance to come up with their own solutions to a unique problem with our guidance. Along the way, they would work with many different tools as they figured out what they needed to do, how to make it work, and what steps were necessary to pull it off. They also learned that, as an integral part of the class dynamics, they would need to work together in teams to identify the best tools for the job, analyze them, and manipulate them to work as needed to achieve their goals.

The phase immediately following the introductory week focused on exploring the technologies the students would employ over the course of the semester. In spring 2016, the "Explore" phase lasted five weeks, during which the students explored social media and outreach, mechanical engineering and prototyping systems, GPS and tracking technologies, 3D printing and design, and digital video production. In spring 2017, this phase lasted four weeks, during which the students explored digital video production, 3D printing and design, social media and outreach, and digital storytelling. Each week, we randomly divided the students into small groups. They spent half their time experimenting with that week's technologies and half their time brainstorming how they could use them to accomplish the overarching goal, sharing their notes with each other in a debriefing session at the end of each week. We also brought in guest speakers so that the students would have access to a wide variety of experts. At the end of this phase, the students submitted individual self-assessments that we used to divide them into teams for the remainder of the semester. We did not want to divide them into teams before they had considered where they wanted to put their efforts, so each student had the chance to gain experience with different emerging technologies prior to beginning the design process.

The "Design" phase lasted three weeks in spring 2016 and four weeks in spring 2017. During this phase, the students worked in teams (organized according to the topics covered during the Explore phase) to brainstorm possible solutions to the semester's overarching goal; Figure 2

Figure 2: Students in the FSU Collaboratory working on payload design in spring 2016

shows students collaborating on the payload design to launch the torches into space in spring 2016. While each team examined a different aspect of the problem, boundaries between the teams were relatively porous, and different team members were constantly sharing ideas with each other. The "Tracking" team during spring 2016, for example, had to work very closely with the "Mechies" team, just as the "Video" team had to collaborate with the "Storytelling" team during spring 2017. Our role as LIS educators during the semester was to serve as project managers for the students, making sure that the different pieces of the puzzle each team was working on would ultimately fit together. Each class also met regularly as a whole to share the teams' ideas and develop an overall strategy for design. At the end of the Design phase, which coincided with the university's spring break, each team submitted their first group progress reports and prepared to bring their designs together after the break.

The Deploy phase lasted three weeks both semesters. During this phase, the students came together to test their designs, assemble prototypes, and prepare for the day when they would put their ideas into action; Figure 3 shows students preparing to create a human torch on the green in spring 2017. This phase featured many last-minute design changes as the students tested their ideas in and out of class (documented in the teams' second group progress reports). The "launch the torch" design, for example, underwent radical revisions in spring 2016 when the students decided to streamline the payload mass to under one kilogram, while the students' plans to "torch the green" in spring 2017 were literally turned upside down when they realized they would get better images if they rotated their design 180 degrees. This phase culminated with the actual event, and in each case the students succeeded magnificently, sending

Figure 3: Students in the FSU Collaboratory preparing to deploy their plans in spring 2017

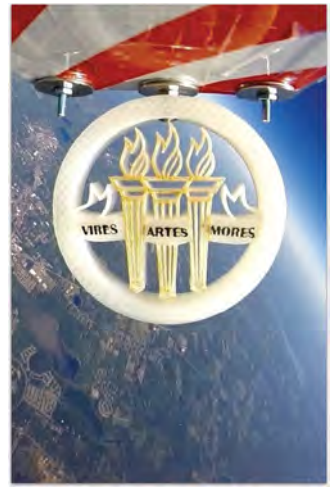

Figure 4: "Launch the Torch"—FSU torches sent 12 miles into space during spring 2016

Figure 5: "Torch the Green"—students forming a torch on Landis Green during spring 2017

their 3D-printed torches twelve miles into space during spring 2016 and arranging hundreds of students in a giant torch centered on FSU's president on Landis Green in spring 2017. Figures 4 and 5 show the students' successful completion of their overarching goals for each semester.

The final phase, the Deliver phase, also lasted three weeks. During this phase, the students gathered as a whole to wrap up the semester, and they created videos to document their efforts and show off their work. Students in the spring 2016 class created two videos: a 360-degree video of the torches flying through space, along with a behind-the-scenes video of the students collaborating to design the payload and plan the launch. Students in the spring 2017 class used images and videos from the flash mob to create a showcase video promoting technological innovation at Florida State University.[5] This phase was a whirlwind of activity and emotion, as the students in both semesters were thrilled by their success and eager to show off their accomplishments. This phase (and each class) culminated with the teams' third group progress reports, and the students' second individual self-assessments, where they detailed what they learned from the project.

Evaluating student learning

Our analysis of course outcomes, course evaluations, and individual student self-assessments helped us determine what our students learned from working with emerging technologies, and how the course changed their ideas about innovating with technology. The outcomes of each class showed how the students were able to design and develop unique solutions that allowed them to meet their overarching goals and provided evidence for the success of the course and student learning about innovation. Even when students with no technology background are placed in an innovation environment, we found that they respond positively to autonomy, overcome challenges, and develop the skills they need to use emerging technologies to accomplish their goals.

In their individual self-assessments, the students wrote about their changing understanding of emerging technologies and what it means to innovate with technology. For example, one of the questions asked on the students' final self-assessment was "How has your understanding of emerging technologies evolved because of this course?" Every student in both semesters was able to provide specific examples of how the class influenced their understanding of innovation and technology. Students also explained how they were able to put into practice the lesson that, when working with emerging technologies, one's goal is not always to create something new but to take something that already exists and use it for a new purpose.

In their course evaluations, the students made it clear how much they appreciated the opportunity to learn about emerging technologies through a hands-on, project-based class. It was encouraging that 100% of the responding students in spring 2016 and 95% of the responding students in spring 2017 rated the overall course content as excellent. Similarly, 100% of the responding students in both semesters agreed or strongly agreed that they learned a great deal in the course, that the instructors stimulated their interest in the subject matter, and that the

course encouraged them to think critically. In their formal and informal comments, students wrote about how they felt engaged and inspired by the unique learning environment offered by the course. Students frequently mentioned how much they appreciated the hands-on and interactive aspects of the class, calling it one of the best they had taken at the university.

Discussion

Throughout each semester, our teaching philosophy remained constant: we set the students a challenge, helped them learn to use the technologies they would need to succeed, pointed them in the right direction, and then got out of their way. The students responded to this freedom by pulling together to accomplish a task that many of them initially thought would be impossible, and they ended up learning new skills and developing a sense of accomplishment that we hope will last them a lifetime. And we learned important lessons that can us help answer our research questions about how LIS faculty can encourage technological innovation in their classrooms and help their universities promote learning through emerging technologies in innovation centers.

Structuring student autonomy

The success of our teaching philosophy depended on our giving students ownership over the structure of the semester, safe opportunities to take risks, and a chance to work together to solve real-life problems. One of the things that made our class work was chunking the steps along the way into achievable milestones for the student groups, so that each individual step was seen as something they could accomplish. The overarching challenge was daunting, and frankly it seemed almost impossible on day one to many of the students, but by providing a comprehensive yet easy-to-grasp structural framework for the semester, we were able to guide the students such that they were always moving, step by step, toward the overall goal, without feeling overwhelmed.

If universities want to help their students innovate successfully through student-driven, student-led initiatives in innovation environments (as addressed in our second research question), then we need to find a way to structure the stress for the students, so that they can focus on the tasks at hand without worrying about how the project will unfold. In our course, we did not give the students specific instructions or micro-manage their process, but encouraged them to have milestones along the way so that their ultimate goals became more manageable. We kept them on task throughout each semester but gave the students control over what they did each day and allowed the students to decide how to move forward at each step. In this way, we were able to encourage student innovation in a controlled classroom setting by providing mechanisms that structured and supported student autonomy.

Creating a sandbox for innovation

The successful completion of each semester's overarching goal depended on our providing a safe space where students could experiment—a sandbox for student innovation where there were no worries about getting things wrong but where everyone could work together on the common problem. Our challenge was not only to help students understand that designing a solution was possible but also to create an environment where they felt comfortable innovating with technology and experimenting with new ideas. We did this by encouraging them to brainstorm many possible solutions, showing them how to use the available technologies, providing access to local experts who could walk the students through any difficulties as they arose, and scaffolding their conversations about which solutions or approaches would be most effective. In this way, we created a safe space where the students could work on projects under their own self-direction, using the tools, technologies, experts, and resources at their disposal.

If universities want their students to acquire hands-on experience with new technologies (thereby addressing the issues raised in our first research question), then they need to provide students with environments where there are no worries about failure, or about being right or wrong. In our Emerging Technologies class, there were no tests to pass or fail; there was just the project, which might or might not work. We made it clear to the students that it did not matter to us whether they accomplished the overarching goal. What mattered to us was what they learned from the process, and that, as it turned out, provided an amazing incentive for the students. They came to the innovation classroom each day because they wanted their project to work—not for a grade but for themselves, because it mattered to them. And as a result, the students were engaged and inspired by the challenges they faced, and they felt encouraged and comfortable experimenting with emerging technologies in the innovation classroom.

Promoting creative inquiry over technology

The success of our learning outcomes depended on our helping the students understand that they were in charge of their own education. Every day we asked them what problem they were going to solve, and for many students this was the hardest question to answer. Far too many students come to class prepared to do what the teacher tells them to do but unable to set their own agendas and imagine their own solutions. When the students in spring 2017, for example, needed to know the dimensions of Landis Green (where they would create the human torch), they were surprised when we handed them a tape measure and a ball of twine and told them to find out for themselves. As university professors, we frequently find ourselves fighting against a learning culture that is centered on reactive instead of proactive learning. Our need to turn that around is perhaps the most valuable lesson learned, and the hardest thing to accomplish.

If universities want to engage their students with a culture of technological innovation (the underlying goal of both of this study's research questions), then we need to help students understand that cultivating a mindset of creative inquiry is more important than simply learning to use technologies. All too often, when we ask our students if they have created a mobile app, or built an online database, or designed a virtual reality game, we are told that they have not, simply because they have not yet taken a course on that subject. Despite having access to a wide range of online videos, tutorials, and resources that would allow them to learn these skills and technologies on their own, they feel unable to tackle such tasks outside the constraints of the formal education system. Our goal as LIS educators promoting innovation on campus should be to turn that attitude around and to help students understand that the future of technological innovation is not about learning technology but about supporting problem solving through technology. By emphasizing creative inquiry, in and out of class, we can help students take a proactive approach to their own education.

Conclusion

Universities are facing a crisis with innovation centers even as they build more of them each year (Wyllie, 2018). It is difficult to determine whether they are working, and even more difficult to define what success means for the students who use them. Counting the tangible benefits that innovation centers provide university students, from the number of 3D artifacts printed to the number of student startups encouraged, is relatively simple. But if we evaluate the success of innovation centers simply by counting the entrepreneurial projects they generate, we risk missing the true potential of a renewed focus on innovation to reshape undergraduate education.

As universities move forward with creating innovation centers for their students, it is important for LIS faculty to remember that the information schools can play an important role. We can use our knowledge, skills, and experiences to engage and inspire students to get involved with technological innovation on campus. We can offer safe spaces where students can find the structured autonomy and confidence they need to succeed, setting their own agendas, driven by their own creativity. We can help our students learn that they do not need to wait for someone else to teach them how to innovate with emerging technologies; they can do this on their own.

It is also important to remember that filling a space full of technology is relatively easy. Building upon the success of the School of Information's Collaboratory, Florida State University has recently opened a 15,000 sq. ft. Innovation Hub,[6] a university-wide initiative with program rooms, study spaces, hang-out spaces, digital fablabs, virtual reality labs, and more—all intended to support the innovation, technology, and design needs of undergraduate students across campus. But it is something very different, and much more difficult, to create a culture of innovation among university students. Faculty and staff at the information schools have the potential to

transform our understanding of what it means to encourage students to innovate with technology and to build a culture of innovation on campus so that everyone can benefit from the amazing technologies and innovations that surround us.

This is not a simple goal. Building a culture of innovation is not easy, especially when this culture needs to cut across the traditional silos of higher education. There is no one magic solution or silver bullet that will work for everyone, and the results of our research are not intended to provide a single tool or method that will work for every situation, student, or class. Instead, the lessons learned from this study highlight the importance of creating a culture among faculty, staff, and students where learning and innovation can thrive via emerging technologies and as such relate to educational goals that we hope all LIS faculty will be eager to pursue.

Naturally, these goals are not only the purview of LIS educators; all faculty on campus have the opportunity to encourage student experiences with technological innovation. But it is important that LIS faculty not let this opportunity pass them by. The overarching problems that today's university students face are no longer isolated in one realm of study requiring expertise in a single field. LIS faculty, by the sheer nature of LIS as a meta-discipline, can make a unique contribution to conversations about technological innovation happening on campus, in the classroom and beyond, despite the fact that many people do not believe LIS faculty have anything to do with innovation and technology at all. If half the battle lies with knowing where to find the information, the other half involves having the means to implement creative solutions. The meta-knowledge that can be acquired through an education made possible by accessible and low-barrier modular technologies (as evidenced by the adoption of makerspaces in libraries) empowers LIS educators to teach collaborative and innovative problem-solving skills.

We are certainly not arguing that these skills can only be learned this way; the recent emphasis on innovation in higher education has prompted many educators to explore the role of creativity and problem solving in the classroom (e.g., DeHaan, 2009). But the history of LIS education speaks to the LIS educator's ability to build solutions to problems through innovation and technology and provides a unique opportunity for LIS faculty to lead the way in addressing these challenges. The future of higher education lies not with teaching specific knowledge but with creating an environment where students have the confidence to learn on their own, and our approach presents one way that students can learn how to learn, which, after all, is the only lesson that truly matters. Once again, learning to use technology is relatively easy; the challenge lies with creatively exploring innovative solutions using technology within the constraints of the available resources in the lives of our students.

LIS faculty know this already; it is part of what we do and who we are. It is the LIS faculty who argue that if you want to know the value of the library

in the community, you have to do more than count the number of books checked out (Wiegand, 2015). It is the LIS faculty who argue for the need to study the library in the life of the user, and not the other way around (Zweizig & Dervin, 1977). And it is the LIS faculty who will argue that it is not the student in the life of the innovation center that matters, but the innovation center in the life of the student—because the true value of the innovation center lies not with the technologies one finds there, but with the people who use those technologies: to teach, to learn, to create, and to imagine.

Paul Marty is professor in the School of Information, and Associate Dean for Innovation in the College of Communication and Information at Florida State University. His research and teaching interests include museum informatics, technology and culture, innovation and design, and information and society.

Rienne Saludo is a Ph.D. candidate and Emerging Technologies Librarian in the School of Information, and the assistant director of Design and New Technologies for the Innovation Hub at Florida State University. His research interests include academic innovation centers, makerspaces, information technology, and information and design.

Castle Kim is a Ph.D. candidate in the School of Information in the College of Communication and Information at Florida State University. His research and teaching interests include the information experience and STEAM, specifically centered on the relationship between creativity and information through the integration of the arts.

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Notes

1. The course syllabus is online at https://marty.cci.fsu.edu/ifs2097/
2. Examples of these reports are online at http://torch.pmarty.org/ and http://green.pmarty.org/.

3. Student videos are online and linked from http://torch.pmarty.org/ and http://green.pmarty.org/.
4. for more details, please refer to the class blogs at http://torch.pmarty.org/ and http://green.pmarty.org/.
5. Student videos from both semesters are online and linked from http://torch.pmarty.org/ and http://green.pmarty.org/.
6. See http://innovation.fsu.edu/.