STUDENT USE AND ACCEPTANCE OF VIDEO PODCASTS IN THE SCIENCE LABORATORY

By

Jessica Caron

A thesis

submitted in partial fulfillment

of the requirements for the degree of

Master of Science in Educational Technology

Boise State University

May 2011

BOISE STATE UNIVERSITY GRADUATE COLLEGE

DEFENSE COMMITTEE AND FINAL READING APPROVALS

of the thesis submitted by

Jessica Caron

Thesis Title: Student Use and Acceptance of Video Podcasts in the Laboratory

Date of Final Oral Examination: 7 February 2011

The following individuals read and discussed the thesis submitted by student Jessica Caron, and they also evaluated her presentation and response to questions during the final oral examination. They found that the student passed the final oral examination, and that the thesis was satisfactory for a master's degree and ready for any final modifications that they explicitly required.

Dr. Kerry Rice	Chair, Supervisory Committee
Dr. Jui-Long Hung	Member, Supervisory Committee
Dr. Chareen Snelson	Member, Supervisory Committee

The final reading approval of the thesis was granted by Dr. Kerry Rice, Chair of the Supervisory Committee. The thesis was approved for the Graduate College by John R. Pelton, Ph.D., Dean of the Graduate College.

DEDICATION

I never thought I would be here, writing another dedication page on another thesis, but it turns out life can take us down many unexpected paths. This time, like last, I feel that there are many people that, either through action or word, have helped me in the process of transitioning this thesis from a possibility to a reality. First, and foremost, I must thank Dr. Jill Rulfs and Dr. Mike Buckholt, who, with patience, persistence, and understanding, has given me more than I could ever thank or repay them for. I appreciate their time, effort, and friendship enormously and will always be grateful.

There are several others whose assistance was invaluable in this process and was greatly appreciated: Ally Hunter for insight into the world of educational research, Dr. Joseph Petruccelli for statistical advice, my committee chair Dr. Kerry Rice for answering my myriad of questions, and the other members of my committee, Dr. Jui-Long Hung and Dr. Chareen Snelson, for their advice and guidance.

Lastly, I must thank my friends and family, especially Ben, Bob, Erin and Kate. Your encouragement, support and editing helped carry me through what has been a very interesting journey.

To all of you I say: Thank you, I could not have succeeded without you!

ABSTRACT

Educational technologies (e.g., computers, social software, personal response systems, and multimedia) have become commonplace in the higher education classroom; however, the full potential of this trend has yet to be realized in the laboratory setting. Technology integration into the undergraduate science laboratory is imperative if we are to, as Hofstein and Lunetta (2004) suggest, engage our current student populations in ways consistent with their experience, knowledge, and preferences. The incorporation of multimedia technologies into the laboratory is one way to meet this charge. Using the Technology Acceptance Model (TAM), this study investigated the student acceptance and usage of podcasting in the undergraduate laboratory setting. The results indicate that students perceived benefits to podcasting for procedural aspects of the laboratory but not for the conceptual aspects that might be assessed on lab quizzes. Student comments indicate that for those with visual and/or aural learning styles multimedia resources, such as the videos provided in this study, may be of particular use in learning. *(Keywords: Higher Education, Science Laboratory, Educational Technology, Web-based video, Web 2.0)*

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1: INTRODUCTION

The science laboratory is, as described by Kohler (2008), “a quasi-natural feature of the world of science: everywhere and nowhere, too familiar to need explication, analytically invisible” (p. 762). As such, it is arguably the cornerstone of undergraduate science curricula. While the laboratory has seen a great deal of change in the past 20 years, much still remains the same in regards to content presentation (Coopers & Kerns, 2006). Frequently students are presented with paper-based laboratory manuals containing cookbook recipe-like instructions that offer little opportunity for direct engagement with the instructional materials or with peers (Coopers & Kerns, 2006; M. Lee, Chan, & McLoughlin, 2006).

Literature consistently reports that laboratory work improves student’s attitudes towards science, increases their interest in science, and motivates them to learn (Hofstein & Lunetta, 2004). However, the current lack of opportunity for student engagement prevents the laboratory from meeting its full educational potential (Coopers & Kerns, 2006). As a unique educational setting, the science laboratory has technology needs and affordances that are separate and distinct from those of the traditional classroom setting. This presents instructors with the opportunity to take selective advantage of the available technologies to more fully engage students in the laboratory and provide students with the immediacy and control that they are used to using in acquiring information.

Strommen and Lincoln (1992) suggest that using multimedia may be one way to accomplish this goal. In particular, the use of video podcasts in the laboratory environment encourages instant access to information, providing students with immediacy and control over content. However, technology must always be integrated into the curriculum with a clear purpose. If it is not, educators risk that students will choose not to use the provided technological resources. According to Abt and Barry (2007), "students need to know not only *what* they are supposed to do, but *why* they are expected to do it and *how* it will enhance their learning if they are to engage with new mobile technologies" (Discussion section, para. 2). Despite being generally characterized as 'always plugged in,' the millennial generation does not engage with technology for the sake of technology (Abt & Barry, 2007), and educational technology is no exception to this trend.

Ideally, laboratory instruction is based on student engagement in investigations. This type of investigation allows students to build mental constructs using the methods and procedures of science, thus integrating procedural and conceptual learning (Bybee, 2000). Available multimedia technologies can be used to engage students in both procedural and conceptual learning tasks in the laboratory. Video podcasting is just one of the many technology tools that instructors are using to address student needs in these areas.

Social software and multimedia in particular are well suited to the unique educational setting of the laboratory. These technologies empower students to engage with the materials and their peers in a fashion that mimics the professional scientific community. Multimedia tools enable instructors and students to engage with materials in ways never before thought possible. For example, wikis and blogs are making the sharing of visual, auditory, and textual information amongst scientists in the laboratory easier than ever (Pearson, 2006). This helps to promote Just-in-Time Teaching (JiTT) and learning amongst the community and is having a positive impact on laboratory education (Dantas & Kemm, 2008; J. Keengwe, Onchwari, & Wachira, 2008b; H. P. Lee, 2002; Nagy-Shadman & Desrochers, 2008; Pearson, 2006) .

Statement of Problem

Hofstein and Lunetta (2004) suggest that it is the responsibility of faculty to rethink and redesign laboratory experiences to engage our current student populations in ways consistent with their experience, knowledge, and preferences. One way to engage our current student population, the digital natives, is through the integration of technology into the curriculum (Prensky, 2008). Yet there is disparity between how technology is being integrated into the traditional classroom setting versus how it is being integrated into the laboratory setting.

In an effort to more fully engage the current student population in the laboratory experience, the introductory laboratory curriculum at the study site was redesigned to include data and content sharing technologies. One of these technologies is a series of video podcasts produced by upperclassmen student project teams. These podcasts demonstrate equipment usage, proper laboratory procedures, and general laboratory how-to information. Specifically, this study sought to evaluate student use and student perceptions of the use of these podcasts in a laboratory classroom where podcasts were considered an active part of the curriculum. A case study following one cohort of students for a single course offering of an Introductory Biology Laboratory course at a small private northeastern American university will be presented.

Purpose of Study

The purpose of this study was three fold: to gauge student acceptance and perception of the provided video podcasts, to gather data on when students are using the provided video podcasts, and to investigate why students chose to use the video provided podcasts. This study specifically sought to answer the following questions:

Q1: What was the demographic makeup and technology background of the student cohort?

Q2: Based on initial exposure to the video podcasts, did students intend to use them for the duration of the course?

If so:

Q3: How were students using the provided video podcast technology in the laboratory context?

Q4: When were students using the provided video podcasts (i.e, in preparing for a lab, executing a lab, and writing up lab reports)?

Q5: Why were students using the provided video podcasts (e.g., what was their intent in using the videos?)

In an academic setting, knowledge of when, why, and how students are using the provided technologies can aid an instructor in making informed decisions regarding technology integration and use. However, once a podcast is provided to students, there is often little to no feedback on its use. Data from this study could also assist laboratory instructors in better targeting the video podcast content to address specific student needs.

Student perception is a very important factor in predicting adoption of a technology in the educational setting (Abt & Barry, 2007). Using the Technology Acceptance Model (TAM), data was gathered on student perceptions regarding the provided podcasts. The TAM model specifically investigates students' perceptions in four areas: Perceived Ease of Use, Perceived Usefulness, Intention to Use, and Attitude Towards Using. The TAM model, developed by Davis in 1989, has been shown in prior research to be a strong predictor of acceptance and subsequent usage of a technology (Davis, 1989; Davis, 1993; Gao, 2005). The TAM model has been applied to research in the educational setting (Elwood, Changchit, & Cutshall, 2006; Landry, Griffeth, & Hartman, 2006; Usluel & Mazman, 2009) and this study, in particular, was based off of previous work by Gao and Walls et al. In addition to the TAM data, data on students' self-reported usage of the video podcasts and their perceived usefulness was also collected.

Limitations and Delimitations

This study was limited to an investigation of student technology use patterns and student acceptance of the video podcasting technology that was integrated into the curriculum at the study site. In this situation, direct assessment of the quantitative impact of video podcasts on student learning was not possible. While historical grade data was available, there have been significant changes in grading staff as well as changes in student demographics over time. In combination, these two factors make direct comparison between the grades before and the grades after the integration of video podcasts statistically invalid. Second, as this is a single population case study, the results may not be applicable to other populations. Lastly, this study was limited due to its reliance on student self-reporting. Two methods were employed to mitigate the limitations of self-reporting. First, the two surveys employed had previously been validated in the literature (Davis, 1989; Gao, 2005). These surveys were deployed with minor contextual modification to address site-specific needs (e.g., some clarifying words were added and site-specific technologies were named). Furthermore, the survey questions were asked anonymously to mitigate students' tendency to report the expected outcome instead of the actual outcome.

Certain delimitations have also been placed on this study. This case study followed one cohort of students for a single course offering in a laboratory following a technology enhanced curriculum. As part of a grant, the curriculum for the investigated laboratory course was redesigned to integrate several technologies during a previous course offering. While there are several software tools being employed simultaneously in the study setting, this study was limited to investigating only laboratory video podcasts.

Definition of Terms

Clicker: See Classroom Response Systems (CRS).

Classroom: Educational setting used mainly for the purpose of lecture delivery.

Classroom Response Systems (CRS): A system consisting of both hardware and software that enables an instructor to poll students. Instructors present the class with questions from a computer equipped with radio frequency (RF) or infrared (IR) receiver. Students then respond to the question using an RF or IR transmitter. Answers are then aggregated on the instructor's computer via the CRS software.

Emerging Technology: Technology tool or technology usage that is based on a novel idea.

Laboratory: See Science Laboratory.

Multimedia: A method of communication that combines different presentation modes (e.g., audio, video, text, and images).

Podcast: Media files (video, audio, images, or a combination of above) made available to students for playback and review. Podcasts are often provided in a format that is designed for use with mobile technologies.

Science Laboratory: An activity or location where students directly engage with materials and scientific methodologies in an effort to explore and understand the physical world (Hofstein & Lunetta, 2004).

Social Software: A wide range of applications (both PC and Web 2.0 based) that enable users to not only interact with information but to also interact with others and share information (Burton Group, 2006; Selwyn & Grant, 2009). Examples of social software include: blogs, wikis, social networking software, and collaborative editing software (Selwyn & Grant, 2009).

Significance of Study

This study was intended to provide some insight into the ways in which students were using podcasts as a part of their laboratory experience, as well as into their impressions of this technology. Knowledge of student use and affect will enable laboratory educators to make informed decisions regarding the integration of podcasts into the laboratory curriculum.

CHAPTER 2: LITERATURE REVIEW

According to Moore's law, technology performance (as quantified by the number of transistors on a microchip) is increasing at an exponential rate (Intel Corporation, 2005; Moore, 1965). Moore's Law, which has held true for the past 40 years, has numerous implications both for our technological computing capabilities as well as for our society. On a daily basis, this increase in technological performance and our societal acceptance of technology can be seen; for example, mobile technologies (e.g., cell phones) have become a nearly ubiquitous and well accepted part of mainstream culture. The technology of today has changed drastically from that of the past, as has the way in which technology is integrated into every facet of our daily lives. The field of education is not immune to this technological shift and technology has become commonplace in the higher education classroom.

While technology integration into the traditional higher education classroom setting has become almost commonplace (J. Keengwe, Onchwari, & Wachira, 2008a; J. Keengwe et al., 2008b), the integration of technologies into the science laboratory setting has lagged significantly behind (Coopers & Kerns, 2006).

This chapter investigates the current state of technology integration into the science laboratory at the higher education level as well as the potential implications of technology integration. This chapter begins with a brief overview of the potential benefits of technology integration in the higher-ed classroom with a specific focus on the integration of video in the classroom. The focus of this chapter is then shifted to the current state of technology integration into the science laboratory, and in particular multimedia such as video podcasts and social software. While most literature on the benefits of technology integration has focused on the traditional classroom environment, the potential benefits of technology integration may also be applicable to the laboratory environment. However, despite any potential benefits to technology integration in the laboratory environment, if students are unwilling to engage with a technology then no benefits will be garnered by its integration. With this in mind, the literature review then focuses on literature surrounding the Technology Acceptance Model (TAM). The TAM can help educators to make informed decisions on the integration of technologies into the classroom as it has been shown to be a strong predictor of user acceptance and subsequent usage of a given technology (Abt & Barry, 2007; Davis, 1989; Gao, 2005). The literature review then concludes with a review of TAM related studies.

This literature review was prepared using resources from several locations including: databases, print and online journals, books and web sites. The following search terms were used: Educational Technology, Education, Laboratory, Science, Undergraduate, Web 2.0, Blog, Wiki, Clicker, Multimedia, Podcast, and Video. EBSCO, IEEE Explore, Google Scholar, ERIC, and Web of Knowledge were all used to conduct online database searches. The impact of integrating technology into the science laboratory does not yet have an extensive literature base (Carvalho-Knighton & Keen-Rocha, 2007). For the purposes of this literature review, the search has been broadened to include laboratories in engineering science areas such as computer science and mechanical engineering. This review uses Hofstein and Lunetta's definition of a science laboratory activity “as learning experiences in which students interact with materials and/or with models to observe and understand the natural world” (p. 31).

Technology Integration in the Higher-Ed Classroom

The endeavor to integrate technology into the classroom is not a new one; to the contrary, technology integration is a movement with a rich past in the United States. Beginning in the early 1900s with the video augmentation of classroom materials (Saettler, 2004; Snelson & Perkins, 2009), educators have been integrating technology into the higher education classroom for the better part of the 20th century. War, cognitive theory, the space race, a shifting economy, the baby boom, the dot com era: each chapter of our history has had its own unique impact on educational technology. Over the years, educational technology has adapted to changing technologies, as well as to changing pressures being placed on our schools, expanding to include new technologies as they emerge and adapting to meet new classroom challenges.

The advent of inexpensive personal technologies has enabled the widespread adoption of a variety of technologies in classrooms around the country. According to Smith et al. (2005) over 50% of educators report using technology in the classroom and these numbers have only continued to rise as computers and Internet access have become more affordable and commonplace at all educational levels in schools across the United States (U.S. Department of Education, Office of Educational Technology, 2004).

Potential Benefits of Technology Integration in the Classroom

As technology in the classroom has become more universal, the literature base investigating its potential impacts on the classroom and on students has also grown. While the literature does indicate that the mere presence of technology does not have an impact on the classroom (J. Keengwe et al., 2008a), there do appear to be some benefits to technology integration that is coupled with sound pedagogy. In the classroom, technology supported instructional models benefit both students and instructors. Technology has been shown to support pedagogically sound instructional models (J. Keengwe et al., 2008a; Peck & Dorricott, 1994), enhance effective classroom teaching paradigms (Cotton, 1991; J. Keengwe et al., 2008a), and have a significant impact on student affect and classroom learning (Kulik, 2003).

Technology use can enhance the students' experience, improving their overall perception of both content and instruction. The use of computers in classroom instruction has been shown to significantly improve student attitude scores towards content and instruction (Culp, Honey, & Mandinach, 2003). Aside from increasing student engagement with classroom materials, the improvement in student attitude has several beneficial side effects. For example, according to Keengwe et al. (2008a), "when teachers use technology as one of the many tools in the instructional repertoire and only when appropriate for completing tasks, students are less likely to become bored" (p. 81).

Technology is a medium with which our current generation of students is very familiar and comfortable. However, the benefits of integrating technology into the classroom go well beyond catering to student preference. History and research have shown us that the integration of technology into teaching and learning can have a direct positive impact on students' affect towards the content as well as on learning outcomes (Culp et al., 2003; J. Keengwe et al., 2008a; Kulik, 1994; Peck & Dorricott, 1994; Prensky, 2008; Richardson, 2008). According to Kulik (2003, p viii):

> Evaluation studies carried out during the 1970s and 1980s also found that computer tutoring has positive effects on student learning. A major meta-analytic review (J. Kulik, 1994), for example, reported that the average effect of computer tutorials was to raise student test scores by 0.36 standard deviations. This is equivalent to a boost in test scores from the 50th to the 64th percentile.

Technology has a long track record in improving both of these outcome measures and in supporting pedagogically sound instructional models. Video, one of the oldest multimedia educational technologies in the United States, is still having an impact on the classroom today.

The Integration of Video into the Classroom

Video, or the motion picture, has been a part of classroom educational technology since 1910 (Saettler, 2004) and its use has continued to grow and change over time. A great deal has changed since the first school in Rochester, NY adopted video for regular instruction. The educational motion picture industry has changed over time both in technology required as well as in film design. The industry has evolved from the cast off theatrical films shown on large semi-portable 16mm projectors that were used for education in the earliest days of video in the classroom to the current use of online video resources in the classroom (Saettler, 2004; Snelson, 2008; Snelson & Perkins, 2009). The relative advantages that video provides, along with the video industry's ability to evolve with the changing technology landscape, has allowed the motion picture to remain a relevant part of today's classroom.

Video provides several relative advantages in the classroom over text alone. For example:

- Video provides the opportunity for students to experience events that are otherwise impossible to see, such as historical speeches or slow motion captures of processes too fast to be seen.
- Video aids instructors in bringing cultural context to lessons by observing people in their cultures.
- Video provides concrete demonstrations of processes that can help make abstract text describing the procedural tasks more concrete (Snelson & Perkins, 2009).

Video demonstrations have the potential to play a large part in classes such as laboratories where procedural learning requirements are high. However, while the positive impact of technologies such as video in the classroom has been well documented in the traditional classroom literature, less attention has been paid to the impact of technology integration into the laboratory setting.

Technology Integration in the Science Laboratory

The science laboratory is, as described by Kohler (2008), "a quasi-natural feature of the world of science: everywhere and nowhere, too familiar to need explication, analytically invisible" (p. 762). As such, it is also frequently the cornerstone of undergraduate science curriculum. The science laboratory is a unique educational setting with technology needs and affordances that are separate and distinct from those of the traditional classroom setting. While a great deal has changed in the science laboratory in the past 20 years, much still remains the same (Coopers & Kerns, 2006). Frequently students are presented with a paper-based laboratory manual containing cookbook-like recipes that offer the student little opportunity for direct engagement with the instructional materials or with their peers (Coopers & Kerns, 2006; M. Lee et al., 2006). Students are not empowered to engage with the materials or collaborate with their peers. However, engagement and collaboration are both imperative if students are to gain an understanding of what it means to be part of a greater scientific community (Zivkovic, Bradley, Stemwedel, Edwards, & Vaughan, 2007).

Hofstein and Lunetta (2004) suggest that it is the responsibility of faculty to rethink and redesign laboratory experiences to engage our current student populations in ways consistent with their experience, knowledge, and preferences. For our current student population, the digital natives, this in many cases means integrating technology in to the curriculum (Prensky, 2008). One of the unique affordances of the science laboratory is that it is an educational setting designed for the exploration of content. As such, students have the opportunity to construct their own knowledge regarding the materials (Shiland, 1999). The integration of technology, and in particular multimedia such as video podcasts and social software, into the laboratory setting may help us to achieve the charge of rethinking our curriculum as set forth by Hofstein and Lunetta (Dani & Koenig, 2008; Hofstein & Lunetta, 2004).

The Scientific Community

The science laboratory is a unique setting where work is often completed in small cooperative groups and students are able to engage each other. This is the beginning of a student's enculturation into the scientific community. The term scientific community, coined by Kuhn (1962) in his seminal work "The Structure of Scientific Revolutions," is used to describe the social thought collective of individuals involved in scientific pursuits. While coined quite some time ago, ‘scientific community’ still aptly describes the types of collaboration and engagement that professional and student scientists engage in today.

According to Karen Honey (2008), “Newer capabilities such as blogging, tagging, and social networking are only just beginning to be exploited by scientists” (p. 1976) in the professional community. As scientists use these tools more often, the students of today will need to likewise become versed in their usage. As a part of the scientific community, it is imperative that our students are prepared to engage with scientific materials and with their peers in a technology mediated way upon graduation (Niedziela et al., 2007).

Communication is just one of the many roles that technology plays in the scientific community. Social software and multimedia are also making the sharing of information amongst scientists in the laboratory easier than ever (Pearson, 2006). Information sharing is imperative in a community of scientists and technology mediation is making this easier than ever.

Technology integration is pervasive in the traditional higher education classroom and professional scientific settings (J. Keengwe et al., 2008a; J. Keengwe et al., 2008b; Niedziela et al., 2007; Pearson, 2006). However, the integration of technologies into the educational science laboratory setting has lagged significantly behind (Coopers & Kerns, 2006) despite the potential for it to have a significant impact on student learning and collaboration (Dani & Koenig, 2008). Technology tools such as wikis, blogs, and data sharing tools can enhance student engagement and collaboration, while podcasts and

Classroom Response Systems (CRS) can be used to support learning on-demand methodologies in the laboratory.

<u>Student Engagement and Collaboration</u>

Wikis, blogs, and data sharing technologies can be used to enhance student engagement and collaboration in the laboratory through writing and problem-based learning. Social software has made writing openly and collaboratively within the laboratory environment easy by providing a vehicle for collaboration in the writing process (Clougherty & Wells, 2008). Tools such as wikis and blogs can facilitate collaborative writing (Clougherty & Wells, 2008; Niedziela et al., 2007; Pearson, 2006) and reflective learning (Chang & Chen, 2007; Clougherty & Wells, 2008; Dantas & Kemm, 2008).

Collaborative writing in the science laboratory engages students with both the scientific content of the lab and with their peers. The process of collaborative writing has been likened to the peer review process that is integral to scientific publishing (Liu, Thorndike Pysarchik, & Taylor, 2002). Through engagement in mock peer review and collaborative writing activities, students form a "scientific social contract" and community of trust in the classroom. Wikis offer a convenient vehicle for engaging with written content in this way.

Wikis are being adopted in the laboratory setting at all educational and professional levels. In the higher education laboratory setting, wikis have proven useful in the creation of collective knowledge bases (Niedziela et al., 2007). Collective knowledge bases offer students the opportunity to share their own insights and lessons learned in the laboratory. This process encourages active learning and allows students the ability to beneficially contribute to the community by engaging with one another by commenting on protocols and sharing their tips, tricks, trials, and tribulations (Pearson, 2006).

Blogs offer another avenue for writing in the laboratory. As blogs represent a more personal reflection on the materials being discussed, they can be very beneficial in promoting meta-cognition and reflective learning. That being said, personal does not necessarily have to equal private; blogs afford us a way to “upgrade personal learning to social learning” (Chang & Chen, 2007) by reflecting on the content as a community. Reflection, in the form of hypothesis generation prior to participation in laboratory exercises, aided students in the correction of misconceptions. According to Dantas and Kemm (2008):

> Students are more likely to correct preexisting misconceptions if they had committed to a prediction and found that it was erroneous when they interpreted their experimental data than those students who performed the experiment without predictions and continued with preexisting beliefs despite the experimental evidence to the contrary. (p. 66)

Blogging offers a tool for reflective writing where students can reflect on the experiment and commit to a prediction prior to engagement in the laboratory activity.

Both blogs and wikis are also gaining some traction as vehicles for Problem Based Learning (PBL) in the laboratory. The technological affordance of social software provides student groups with convenient ways to collaborate around problems and engage with materials. For example, student teams can use wiki tools to aid them in developing their approach to a problem in a PBL activity. The wiki serves as a staging area for the group investigation of the problem and development of protocols to investigate their hypothesis. Blogs and wikis allow students participating in PBL the ability to contribute to the overall project and participate in the peer review process.

Classroom Response Systems (CRS), often called Personal Response Systems or Clickers, are another example of technology that was first integrated into the classroom but is now finding a home in the laboratory. Classroom Response Systems consist of a receiver and wireless polling devices. The student polling device (aka clicker) is used by the students to submit responses to instructor deployed questions. While this process bears strong resemblance to the voting on shows like “Who Wants to be a Millionaire” or “America’s Funniest Home Videos,” the use of clickers in the laboratory is a powerful Just-in-Time Teaching (JiTT) tool that can have significant impact on student affect and performance.

Through the use of probing questions coupled with corrective instruction, clickers offer an opportunity for JiTT in the laboratory. The laboratory setting offers a unique educational setting where clickers can aid in judging student readiness and increasing student engagement with the materials. Some studies have shown as much as a one standard deviation improvement in student achievement when students were offered the type of immediate feedback that is provided through clickers. In addition, students self report that clickers in the classroom aid them in: increasing learning, decreasing “daydreaming,” increasing class participation, and increasing communication with the instructor as well as engagement with the class (Dantas & Kemm, 2008; Nagy-Shadman & Desrochers, 2008).

Clickers can also be deployed in non-traditional ways in the laboratory that allow students to connect with one another as well as with the laboratory content. For example, in Hunter et al. (2010), students used the clicker technology as a real-time class-wide data gathering device. Students reported deeper understandings of statistical concepts as well as increased confidence in their laboratory results as a direct result of the use of this technology in the laboratory a result consistent with other analyses of clicker use in the classroom (Hunter, Caron, Rulfs, & Buckholt, 2010).

JiTT and Learning-on-Demand: The Integration of Video into the Laboratory

Providing students with just-in-time or learning-on-demand materials (Gee, 2003), can have a big impact on the laboratory. Learning-on-demand materials can aid in taking the focus off the procedural aspects of the laboratory and allowing students to focus on the conceptual aspects of the science behind the laboratory. Video can provide an easy medium for instructors looking to integrate learning-on-demand materials to address procedural concepts in the laboratory curriculum (Abt & Barry, 2007).

By creating short video segments addressing laboratory concepts, instructors are able to provide students with an on-demand resource to aid them in their learning. Podcasts assist students in several ways. Podcasts have been shown to increase the accessibility of laboratory materials for students of varying learning styles (Colombo & Colombo, 2007). For students who have difficulty with written directions, a video demonstration of the procedure can aid them in the laboratory. Video podcasts can also capture the dynamic nature of a laboratory protocol in a way that is not possible in just text (Pearson, 2006).

Several benefits to providing students with easily accessible dynamic content addressing procedural laboratory information (e.g., ‘how is this piece of equipment supposed to be assembled?’ or ‘what are the possible outcomes of this assay?’) have been demonstrated in the literature. Learning-on-demand materials in the form of podcasts can increase learner autonomy (Diederen, Gruppen, Hartog, & Voragen, 2005), creating a laboratory environment that is efficient and motivating for both students and staff. This type of material can also have a positive impact on student performance (Abt & Barry, 2007). However, the potential benefits of podcasting for learning-on-demand materials can only be realized when the technology is coupled with sound pedagogical techniques (Dantas & Kemm, 2008), such as objective-driven design (Fink, 2003) or “learning by teaching” (M. Lee et al., 2006).

Learning by teaching is a teaching strategy that can be employed in the construction of learning-on-demand materials for the laboratory. For example, in the Students as Producers model, students create learning-on-demand podcast content for their peers or for later cohorts. This process of podcast creation engages the students in “learning by teaching,” which has both meta-cognitive benefit as well as cognitive benefits. The student producers are forced to examine not only the content to be demonstrated in the podcast but also their own understanding of that content. This leads to increased comprehension for the student producers as well as materials that can benefit the other students (M. Lee et al., 2006). While podcasting is one model for the delivery of learning-on-demand content via technology in the laboratory, it is only one model out of the many demonstrated in the literature.

The Integration of Video Podcasts into the Laboratory

Video podcasts have been integrated into laboratory-based courses in several different manners. For example, Trelease (2008) has described a system where colonoscopy videos, previously only available on computers, have been converted to a podcasting format for anatomy students. This enables the students to view the videos on their portable devices at a convenient time (Trelease, 2008). In another laboratory related study, researchers created podcasts for students demonstrating key microbiological skills (Crampton, Vanniasinkam, & Ragusa, 2008). In this study, Crampton, Vanniasinkam, and Ragusa found that students who used the resource felt the supplemental video podcasts were a useful tool in the laboratory. In particular, students felt that the videos were useful in preparing for lab practical experiences (Crampton et al., 2008). This finding suggests that laboratory video podcasts may be useful as a supplement to the often static laboratory manual (Crampton et al., 2008).

The laboratory manual is at the heart of any laboratory course. While it is often provided electronically, the document itself is most often static. The document leads students through the procedure to be followed, often focusing a student's attention on the procedural aspect of the laboratory rather than engaging them in higher order thinking. The laboratory manual is one area in which technology, social software, and multimedia are having impacts in the laboratory (H. P. Lee, 2002). The incorporation of multimedia learning-on-demand materials into the laboratory manual has the potential to make the manual more accessible for students of all learning types (Pearson, 2006). However, this potential can only be realized if students are accepting of the technology and willing to engage with it. Therefore, the ability to predict user acceptance and subsequent usage of a given technology is important.

Technology Acceptance Model

The Technology Acceptance Model (TAM) is one methodology used to gauge a population's acceptance of a given technology. Developed in 1989, the TAM is based on earlier work with the Theory of Reasoned Action (TRA) (Davis, 1989; Fishbein & Ajzen, 1975). TRA is a measure of user behavioral intent as judged by user beliefs and attitudes towards a specific action (Fishbein & Ajzen, 1975). The TAM expanded on this earlier work by not only investigating user attitudes but also considering the target population's perceived ease of use and perceived usefulness of a technology (Davis, 1989). The TAM specifically investigates user perceptions in four areas: Perceived Ease of Use, Perceived Usefulness, Intention to Use, and Attitude Towards Using. Taken together these four areas measured by the TAM have been shown to be a strong predictor of user acceptance and subsequent usage of a given technology (Abt & Barry, 2007; Davis, 1989; Gao, 2005).

The TAM has proven to be a robust model for predicting user acceptance. This model has been applied to research in several diverse fields such as: word processing (Davis, 1989), telemedicine (Hu, Chau, Sheng, & Tam, 1999), work related tasks on the Internet (Lederer, Maupin, Sena, & Zhuang, 2000), and to technologies in the educational setting. In the higher education setting topics such as laptop initiatives (Elwood et al., 2006), the BlackBoard Learning Management System (LMS) (Landry et al., 2006), Web 2.0 tools (Usluel & Mazman, 2009), and educational hypermedia (Gao, 2005) have been investigated using the TAM.

Since it has proven to be such a robust model, the TAM has become one of the most commonly used acceptance models in the Information Sciences (IS) and has gone through four distinct stages of development (Y. Lee, Kozar, & Larsen, 2003). These four periods have been defined as the Introduction period, the Validation period, the Extension period, and the Elaboration period. In the Introduction period, TAM was introduced to the field of IS and began to gain traction as a potential model for predicting user acceptance. This gave way to the Validation period where TAM was rigorously studied for robustness and validity. Next came the Extension and Elaboration periods where additional factors such as gender were overlaid with the basic TAM investigations and the TAM was developed further (Y. Lee et al., 2003). During each of these phases the TAM was refined and in some cases redefined as was the case with the TAM2 (Venkatesh & Davis, 2000).

However, despite its robust nature, the TAM does have some shortcomings. One of the instrument's most notable shortcomings is the instrument's reliance on user self-reporting (Y. Lee et al., 2003). Some critics have argued that user self-reporting may not be a strong long-term predictor of future use of a technology despite user acceptance. While this shortcoming has been acknowledged, the TAM has still proven to be a solid predictor of user acceptance despite being subject to common methods bias (CMB). Another often cited shortcoming is the lack of accounting for the "voluntariness" of a computing technology in the TAM (Y. Lee et al., 2003; Venkatesh & Davis, 2000). If a computing technology is considered non-optional, and therefore its use is not considered voluntary, user responses may be skewed in areas of the TAM such as Perceived

Usefulness. This type of skew would also skew the results of the acceptance survey towards a more positive outcome (Venkatesh & Davis, 2000).

Related Studies

The TAM has been specifically applied to the user acceptance of podcasting technologies (Gao, 2005; Gribbins, 2007; Huang, Yoo, & Choi, 2008; Kemp, Myers, Campbell, & Pratt, 2010; Saeed, Yang, & Sinnappan, 2009; Walls et al., 2010). For example, Gribbins (2007) investigated the level of student acceptance of podcasts as an educational tool using the TAM framework. Gribbins found that while students had not had much prior exposure to podcasting as an educational tool, they did perceive the tool to be potentially useful in the educational setting. Perceptions of usefulness, however, did not extend to student grades as the students in this study did not feel that podcasting would improve their performance in the course (Gribbins, 2007). This finding was later supported by Kemp et al. (2010). In their paper on student perceptions of podcasting, Kemp et. al. found that "despite lack of statistically significant data that support podcasting as a means of enhancing learning, student perception and anecdotal feedback encourage educators to use podcasting." Therefore while the current data does not indicate that podcasting enhances learning, there is support for podcasting from a user acceptance standpoint (Kemp et al., 2010).

This study in particular was based off of previous works by Gao and Walls et al. The first study the work presented here was modeled after was Gao (2005). In the Gao (2005) study, student acceptance of a textbook companion educational hypermedia site was investigated using the TAM framework. The study presented here parallels the Gao study in that the video podcasts being investigated were intended to accompany a laboratory manual. In his study, Gao validated the use of TAM as a tool for instructors to use in evaluating and selecting hypermedia-based educational technologies.

The second study the work presented here was modeled after was Walls et al. (2010). In the Walls et al. (2010) study, students' readiness to engage with podcasting in an educational setting as well as their attitudes towards doing so were investigated. Walls et al. found that while students who utilized the podcasts felt that podcasting had a positive impact on their learning, students in general may not be ready to engage with podcasts as a learning tool. Walls et al. noted students do not associate this type of resource with education and therefore need reinforcement from educators that this type of a tool can be useful to them in their education. The data on podcasting in the traditional classroom educational environment does not currently support the theory that podcasting has a direct positive effect on grades (Gribbins, 2007; Kemp et al., 2010; Walls et al., 2010). However, students do appear to feel that podcasting could be beneficial to them in their studies (Gribbins, 2007; Walls et al., 2010). The study presented here parallels the Walls et al. study in that students' readiness to engage with video podcasting in the laboratory and their attitudes towards doing so were investigated.

Summary

While the technology of today has changed drastically from that of the past, retrospective studies of our past experiences can help us to move forward into the future with confidence. No longer is the education community focused on the question of 'is technology effective?', rather the focus has changed to looking at how technology can be leveraged in the classroom to support both teaching and learning. We are already aware that the integration of technology into the classroom has a positive impact on teaching and learning when it is integrated into the curriculum in support of instructional objectives. As a community, we must continue to research the ways in which technology can be integrated into the laboratory, as well as the classroom, to effectively engage our current student population while enhancing student learning and interest in course materials.

The current literature suggests that technology integrated into the traditional classroom in conjunction with sound pedagogy can have a positive impact on student engagement and learning outcomes. However, the literature on the impact of technology integration on teaching and learning in the laboratory lags significantly behind. The existing literature base suggests that the integration of emerging technologies into the laboratory setting has the potential to have an impact similar to that of technology integration into the traditional classroom. In particular, literature suggests that video technologies may have an even greater impact in the laboratory due to the laboratory's unique educational setting that focuses on procedural learning. Incorporation of video learning-on-demand and JiTT materials can aid in taking the focus off the procedural aspects of the laboratory, allowing allows students to focus on learning concepts as they are completing procedures.

CHAPTER 3: METHODOLOGY

Research Design

This case study followed one cohort of undergraduate college students for a single offering of a biology laboratory course, BB2901, entitled “Molecular Biology, Microbiology, and Genetics.” This study endeavored to gather information regarding student use and perceptions of podcasts in a laboratory classroom. The case study methodology was chosen for this study in order to allow an in-depth look at the relationship between student acceptance of the provided technology, video podcasts, and their subsequent usage of the technology in the context of the laboratory (both in preparation for and in execution of laboratory activities). The case study methodology is appropriate for this purpose as it is particularly well suited to the investigation of a single aspect, in this case acceptance and use of video podcasts, in a single cohort (Baxter & Jack, 2008; Gray, 2004; Leedy & Ormrod, 2009). Video podcasting is a multimedia resource that can aid students in the mastery of procedural laboratory concepts. However, this tool can only be successful if students are accepting of the technology and subsequently choose to utilize it. This study specifically sought to answer the following questions:

Q1: What was the demographic makeup and technology background of the student cohort?

Q2: Based on initial exposure to the video podcasts, did students intend to use them for the duration of the course?

If so:

Q3: How were students using the provided video podcast technology in the laboratory context?

Q4: When were students using the provided video podcasts (i.e, in preparing for a lab, executing a lab, and writing up lab reports)?

Q5: Why were students using the provided video podcasts (e.g., what was their intent in using the videos?)

Based on previous literature on podcast in the classroom (Gao, 2005), it was hypothesized that students would be amenable to the video podcasting technology and willing to use it in their studies.

Case Study Methodology

The case study is a research methodology that focuses on an aspect of a single cohort (Baxter & Jack, 2008; Gray, 2004; Leedy & Ormrod, 2009). The single case study follows a single aspect of a single cohort (Leedy & Ormrod, 2009) and seeks to "explore or describe a phenomenon in context using a variety of data sources" (p. 554) (Baxter & Jack, 2008). As case studies are context sensitive, generalization of the finding is limited to situations where the context is similar (Baxter & Jack, 2008; Gray, 2004; Leedy & Ormrod, 2009).

The case study methodology was particularly well suited for this study where user acceptance was being investigated. According to Gray (2004), "Case studies…explore subjects and issues where relationships may be ambiguous or uncertain. But, in contrast to methods such as descriptive surveys, case studies are also trying to attribute *causal* relationships and are not just describing a situation" (p. 124). The data gathered will enable the development of a model of causal relationship between student perceptions of and usage of podcasts in the laboratory that may be applicable to other laboratory environments.

Participants

This study followed one cohort of students in an introductory biology laboratory for the duration of one seven-week course. The curriculum in the laboratory course under observation actively employed several technologies, including podcasts, as a part of the student learning experience. Other technologies used in this course included use of the Echo 360 Lecture Capturing system to record the lecture portion of the class and use of the eInstruction Classroom Performance System to engage students in the laboratory.

The course, titled "Molecular Biology, Microbiology, and Genetics," was an open enrollment course where students self-selected for enrollment. For the purposes of this study, all students enrolled in this course were considered members of the cohort. This was due to the small population of enrolled students in the course (94 students) (Gray, 2004; Leedy & Ormrod, 2009). The study surveys were distributed to the entire cohort population: however, despite cohort membership, students were not required to participate in the study and no penalty was associated with nonparticipation. Detailed student demographics were collected via survey instrument as part of this study and are provided in *Chapter 4: Findings.*

Video Podcasts

Video podcasting was integrated into the curriculum of an introductory biology laboratory course during the '09 -'10 academic year. The podcasts were created using a 'student as producer' methodology where students completing an advanced degree requirement produced videos for the introductory laboratory sequence. The video podcasts created addressed procedural aspects of the laboratories. They focused on topics such as:

- How to perform a specific laboratory technique (e.g., how to load an agarose gel)
- How to operate a piece of laboratory equipment (e.g., microfuge and centrifuge operation)
- What are the specific safety concerns in a laboratory

These videos were made available to students enrolled in the laboratory course in several ways, such as through the university's YouTube.edu channel, http://www.youtube.com/user/WPI#grid/user/E597F22DB929D8FD (Figure 1: Video podcast examples), and through the course management system. Laptop computers were available at each laboratory station to allow students universal access to these materials during the laboratory class period.

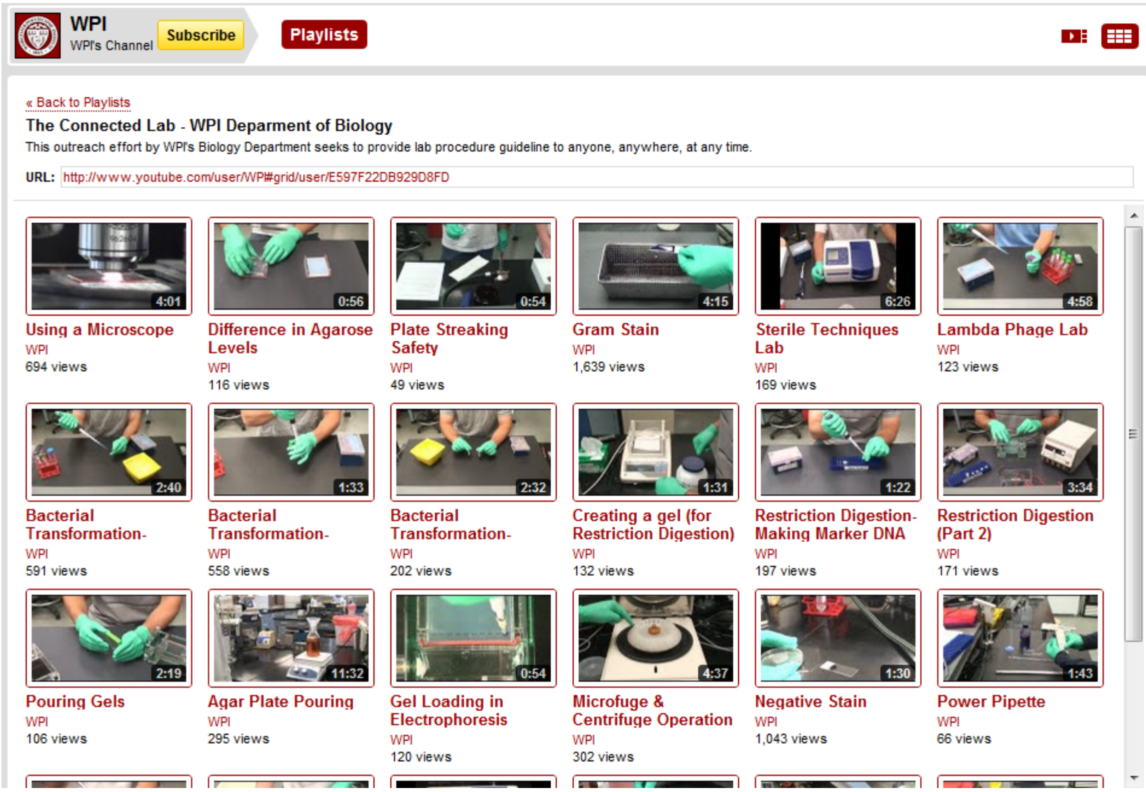

Figure 1: Video podcast examples. Video Podcasts are made available to students in several ways including the university's YouTube.edu Channel

Procedures

This study followed one cohort of students in an introductory biology laboratory for the duration of one seven-week course. In accordance with the study site’s ethics policy and federal guidelines (The Common Rule, 45 CFR 46), Institutional Review Board (IRB) approval was sought and obtained prior to the initiation of this study. Please see *Appendix A: Institutional Review Board (IRB) Protocol Approval* to review the IRB approval letter.

To ensure that students understood the purpose behind the survey being delivered to them, it was imperative that the nature and purpose of the study was explained to them. For this reason, the students in this course were notified regarding the study both verbally in class as well as in writing via email at the beginning of the course. Students were reminded, both verbally and in writing, that their participation in this study was entirely voluntary and that there was no penalty for choosing not to participate. Please see *Appendix B: Informed Consent* to review the Informed Consent statements.

Students choosing to participate were provided with a small incentive for their participation. Each student was awarded four bonus points for filling out one survey. This amounted to a possible bonus of 12 points for taking all three of the study surveys. These 12 bonus points constituted 2.5% of the total number of available points in this course (475 points were available in total). These 12 points were enough to help a student on the bridge between letter grades, if they were very close to a grade cutoff point, but it would otherwise not be a significant influence on a student's overall course grade.

All study materials were administered in an anonymous fashion through the university's content management system, BlackBoard (Bb). Bb was used as it provided a FERPA compliant secure area for data collection as well as tools for anonymous data collection. All surveys were likewise deployed in a fully anonymous fashion through Bb. It was hoped in both situations that anonymity would prevent data skew and limit student concerns regarding grading impact.

This study consisted of three surveys that were deployed at specific times over the period of one seven-week laboratory course (Figure 2: Survey Deployment Timeline). The first survey, designed to gather data on student demographics and students prior experiences with video podcasting, was deployed following the first class meeting. The first survey remained available to students until the deployment of the second survey. The second survey, the Technology Acceptance Model (TAM) survey, specifically investigated early perceptions and acceptance level of a particular technology. Students enrolled in the course were exposed to the laboratory video podcasts over the course of the first week of class. Since early perceptions have been shown to be a strong predictor of continued technology use, the TAM survey was made available to students following this first week of exposure. This survey remained available to students until the start of their third week of class. The last survey was designed to gather both quantitative as well as qualitative information on how and why students have chosen or not chosen to use the provided podcasts during the course.

The exit survey was deployed at the beginning of the sixth week of this seven-week course. The survey was provided slightly before the end of the course for two reasons. First, the last week of the course curriculum does not currently contain a provided video podcast due to the open-ended nature of the last lab. Secondly, it was hoped that the extra time would maximize response to the exit survey during an extremely busy time. Prior to the deployment of each survey, students were reminded both verbally as well as in writing of the study and asked for their continued participation.

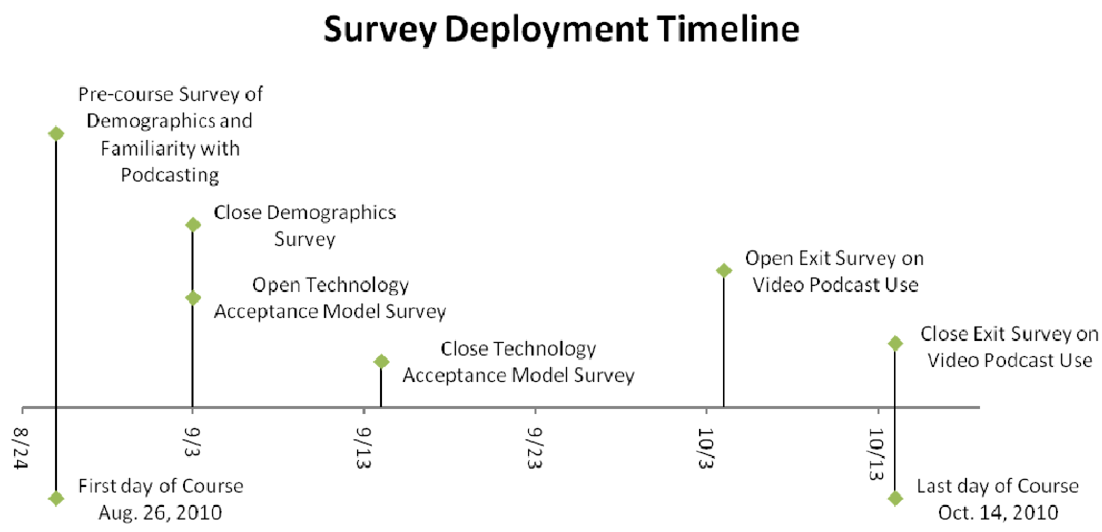

Figure 2: Survey Deployment Timeline

Data Collection Instruments - Surveys

Descriptive surveys can be used to gather data regarding the characteristics of and data on a population (Gray, 2004). Student surveys were employed in order to gather the data necessary to address the proposed research questions. The survey methodology employed consisted of three individual questionnaires distributed to the entire class through an electronic distribution mechanism (Blackboard's Survey Manager). Qualitative and quantitative data were gathered through the deployment of the survey. Use of the surveys sought to gather data on: student demographics, prior knowledge of and experience with podcasting technologies, student technology acceptance, and student technology usage. Demographic data were collected through a series of multiple choice questions and all other data were gathered through a series of open-ended and Likert scale questions. The response rate for all three surveys was 96% of students (n=94) responding to the Pre-course Survey of Demographics and Familiarity with Podcasting survey, 95% of students responding to the Technology Acceptance Model (TAM) survey, and 85% of students responding to the Exit Survey on Video Podcast Use.

In order to address the research questions (see Research Design), data were gathered on students' acceptance and willingness to utilize the provided video podcasts as well as on their usage of the provided video podcasts. Preliminary data regarding students' demographics and prior experience with podcasting were gathered as baseline information on the cohort. This information was collected using the Pre-course Survey of Demographics and Familiarity with Podcasting (Appendix C, adapted from Walls et al., 2010) and was used to address Question 1: "What is the demographic makeup and technology background of the student cohort?"

Question 2: "Based on initial exposure to the video podcasts, do students intend to use them during the duration of the course?" was investigated using the Technology Acceptance Model (TAM) developed by Davis (1989) and modified by Gao (2005). The TAM questioner can be viewed in Appendix D.

Questions 3-5 (see Research Design) were addressed using an exit survey delivered towards the end of the course. The exit survey, entitled Exit Survey on Video Podcast Use (Appendix E, adapted from Walls et al., 2010), asked questions regarding actual student usage of the provided podcasts.

Data Analysis

Following data collection, data from each of the surveys were analyzed independently and then evaluated holistically in an attempt to address the research questions. First, collected demographic data were summarized and presented as a narrative to describe the studied cohort as well as to lend context to the study results. Next, descriptive statistics were computed for all Likert scale items with focus on means and standard deviations. Where appropriate, Likert scale items were further analyzed for statistical significance. For example, Likert scale items on the second and third surveys were analyzed using a two-tailed Wilcoxon signed rank test to check if student responses were statistically different from the neutral response (Joosten et al., 2005; Motulsky, 2010). This analysis was done using non-parametric statistics as the student response values did not meet the assumptions for Gaussian distributions that are required for the use of parametric statistics. Statistical analyses were completed using both Excel and GraphPad InStat.

Finally, qualitative information from open-ended questions was analyzed for trends through the use of selective coding (Gray, 2004). Qualitative data was reviewed and analyzed for repeated themes and keywords. These repeated themes and keywords, once identified, were then used to categorize the individual responses to qualitative questions. The coded data was then summarized based on counts for each identified theme and used in narrative form to add additional context to the quantitative results of the Likert scale items.

CHAPTER 4: FINDINGS

Student response rate for the deployed surveys was very high. Ninety percent (85 out of 94) of students in the target population completed all three surveys. Ninety-nine percent (93 out of 94) of students completed at least 2 out of the 3 surveys. Nine students out of the 94 completed only two surveys while only one student out of the 94 students completed only one survey.

Q1: What is the Demographic Makeup and Technology Background of the Student Cohort?

The first survey employed several questions that directly addressed the first research question: What is the demographic makeup and technology background of the student cohort? While it was already known that the student population at the study site is of traditional age for students proceeding directly to college from secondary school, there were several unknown factors regarding the student population enrolled in this course. The unknown factors consisted of things such as: grade level, majors, gender, course background, and technological background.

The studied student cohort consisted predominantly of sophomore Biology and Biotechnology majors. Of the students in the cohort, 5% were freshmen, 53% were sophomores, 20% were juniors, and 18% were seniors. One student (1%) reported a Grade Level of Other. Students came from several different academic majors as can be seen in Table 1. Life Science Majors (Biology and Biotechnology (BBT), Chemistry and

Biochemistry (CBC), Biomedical Engineering (BME)) constituted 90% of enrollments with the majority identifying as Biology and Biotechnology Majors. While the general student body at the study institution is predominantly male (70% in fall of 2010), student enrollments in the life sciences demonstrate a more balanced gender distribution with approximately 63% of life science students being female (fall of 2010) (WPI Division of Enrollment Management, 2010). This course offering was representative of the aforementioned life science enrollment trend with 66% of the enrolled students being female.

Table 1

Majors of Students in the Study Cohort

Declared Majors of enrolled students

Major	**Count (n)**	**Percentage**
Biology and Biotechnology (BBT)	55	63%
Biomedical Engineering (BME)	12	14%
Chemistry and Biochemistry (CBC)	11	13%
Double Majors (BBT + CBC)	4	5%
Chemical Engineering (ChE)	2	2%
Mechanical Engineering (ME)	1	1%
Computer Science (CS)	1	1%
Unanswered	2	2%

The study course is one of four courses in a biology laboratory series. Of the students enrolled in this course, 47% had previously taken at least one other lab in this series. This indicates that a certain percentage of the students have had previous experience with the teaching and learning methodology employed in this course as these techniques are also employed in the other courses in this laboratory series. This, coupled with students' prior experiences in other courses, may have influenced the overall student familiarity with podcasting.

In the study cohort, all but one student reported having participated in at least one other course that provided audio or video files as a supplemental resource and 70% of students indicated they were familiar with podcasting (Table 2). However, despite the fact that these students indicated a general familiarity with podcasting, they also reported a lack of knowledge regarding video podcasting/podcast technology. Only 12.5% of students indicated that they were fairly knowledgeable regarding video podcasting/podcast technology and 25% of students indicated that they were not at all knowledgeable.

Table 2

Familiarity with Podcasting and Knowledge of Podcasting Technologies

Are you familiar with podcasting?

Response Choices	Count (n)	Percent
Yes	62	70%
No	26	30%

How knowledgeable are you with video podcasting/podcast technology?

Response Choices	Count (n)	Percent
Not at all knowledgeable	22	25%
A little knowledgeable	33	38%
Neutral	22	25%
Fairly knowledgeable	11	13%
Very knowledgeable	0	0%

Data were also gathered regarding what types of activities students were engaging in pertaining to digital audio and video files (Table 3). Students reported that they were most likely to use these technologies for entertainment purposes such as listening to music, watching TV shows, or watching short videos. The activities that students were the least likely to engage in were non-required academic activities, which included listening to speeches/interviews not required for class, watching other [not lecture captures or recorded lectures] information related to their college courses, and listening to audio books. Despite this, students are also engaging with academically focused digital audio and video files that may be perceived as more integral to the curriculum. Students reported either watching or listening to class lectures frequently with 75% of students reporting that they either watch or listen to at least one class lecture on a weekly basis.

Table 3

Frequency of Student Engagement in Activities

Listening to music

Response Choices	Count (n)	Percent
Three or more times a day	39	44%
Once or twice a day	27	31%
At least weekly, but not daily	16	18%
At least monthly, but not weekly	5	6%
Less than once per month	1	1%
Never	0	0%
Unanswered	0	0%

Listening to recorded books

Response Choices	Count (n)	Percent
Three or more times a day	0	0%
Once or twice a day	1	1%
At least weekly, but not daily	1	1%
At least monthly, but not weekly	6	7%
Less than once per month	16	18%
Never	64	73%
Unanswered	0	0%

Listening to speeches/interviews not related to your college courses

Response Choices	Count (n)	Percent
Three or more times a day	0	0%
Once or twice a day	0	0%
At least weekly, but not daily	13	15%
At least monthly, but not weekly	19	22%
Less than once per month	23	26%
Never	33	38%
Unanswered	0	0%

Listening to class lectures

Response Choices	Count (n)	Percent
Three or more times a day	2	2%
Once or twice a day	13	15%
At least weekly, but not daily	24	27%
At least monthly, but not weekly	14	16%
Less than once per month	25	28%
Never	9	10%
Unanswered	1	1%

Listening to other information relevant to your college courses		
Response Choices	**Count (n)**	**Percent**
Three or more times a day	1	1%
Once or twice a day	5	6%
At least weekly, but not daily	26	30%
At least monthly, but not weekly	19	22%
Less than once per month	19	22%
Never	18	20%
Unanswered	0	0%

While students reported that many of their previous courses have offered audio or video files, many students also reported that they did not take advantage of these resources. Fifty-five percent of students who had previously taken a class with audio or video files reported that they used the files never or not very often. This is despite the fact that students report that these resources contribute to their learning more than somewhat (52% of students report that these resources help: Somewhat 20%, Quite a bit 27%, or A lot 5%), and in general students indicated that access to such resources would be useful to them in their studies (Table 4).

Table 4

Student Perceived Usefulness of Resource Type

In general, do you think it would be useful for you to have access to audio or video files of class resources?

Resource Type	**Count (n)**	**Percentage**
Class lectures	76	86%
Overviews of difficult concepts	72	82%
Lectures and slides integrated together	71	81%
Demonstrations of laboratory procedures	71	81%
Guest speakers	44	50%
Supplemental material from experts or authors in the field	36	41%

In open-ended responses, students cited several reasons that they either liked or disliked audio or video files as a class resource. When asked what the biggest benefit of audio and video files were, students cited the following benefits:

- Class Review (reasons given: recap, exam, increasing comprehension of difficult area)
- Access to classes missed due to illness, skipping, etc.
- Level of access (e.g., "can access them whenever you like")
- Taking notes or Refining notes taken during lecture
- Reviewing demonstrations to increase comprehension (lab-based or problem-based)

- Different mode of learning is addressed with audio visual resources

Of the 63 open-ended responses provided, 29 cited the benefit of using audio and video files for class review for various reasons, such as reviewing a class, preparing for an exam, or increasing their comprehension of difficult areas. Twelve of the 63 open-ended respondents also noted that such resources aid them in gaining access to classes missed due to illness, skipping, etc. When asked what the biggest limitation of audio and video files were, students cited the following limitations:

- Technical difficulties
- Video/ audio is too long so it is hard to find the section you want to review
- Video is not as rich an experience as going to class
- Files are too large (storage space issues as well as length of time to download)
- Encourages some students to skip
- Redundant resource
- Cannot ask questions while listening to capture
- Becomes boring

The greatest weakness in using this type of resource was cited as technical difficulties (14 out of 37 respondents). Students were also asked to identify the ways in which podcasts would or would not benefit them. The answers to this question were parallel to the perceived strengths and weaknesses of these tools listed above.

Q2: Based on Initial Exposure to the Video Podcasts, do Students Intend to Use Them During the Duration of the Course?

Following the first laboratory, students were presented with the Technology Acceptance Model (TAM) survey developed by Davis (1998) and modified by Gao (2005). The data from this survey was used to investigate the second research question: Based on initial exposure to the video podcasts, do students intend to use them during the duration of the course? The scale used for this survey was: Definitely Disagree (1), Mostly Disagree (2), Somewhat Disagree (3), Neither Agree nor Disagree (4), Somewhat Agree (5), Mostly Agree (6), and Definitely Agree (7).

The data were analyzed using a two-tailed Wilcoxon signed rank test to establish if student responses were statistically significantly different from the neutral response of Neither Agree nor Disagree (converted numerical value of 4). Student responses were statistically significantly different in all cases (CI=95%) except one. The students taking this survey did not feel that the laboratory video podcasts aided them in being more productive in their work.

The survey questions and results were grouped into four independent sections for closer analysis: 1) Student perceived ease of use (Table 5), 2) Student perceived usefulness (Table 6), 3) Student attitude toward using (Table 7), and 4) Student intention to use (Table 8). The results of these sections taken together can be used to gauge the overall user acceptance of a technology-based system. Students perceive that the laboratory video podcasts were easy to use and navigate (Table 5) and they generally perceive that the videos were useful to them in their studies (Table 6). The one exception to this perceived usefulness was in the area of productivity; while the mean response was above neutral, the results were not significantly different from neutral.

Students conceptually favored the use of the laboratory video podcasts and agreed that the videos were a good idea (Table 7). Students did indicate an intention to use the videos moving forward. As seen in Table 8, students indicated they planned to use the video podcasts throughout the term. All three questions used to assess student's commitment to using the videos were significantly favorable. However, the two questions that specifically stated intent were highly significant.

Table 5

Technology Acceptance Model Survey of Video Acceptance: Student perceived ease of use

Question Items	**Count (n)**	$\bar{x}$	**Mode**	**SD**	**Wilcoxon signed rank test (P)**
I found the video podcasts easy to use.	89	5.4	6	1.3	< 0.0001**
Learning to use the video podcasts would be easy for me.	89	5.8	6	1.1	< 0.0001**
My interaction with the video podcasts was clear and understandable.	89	5.6	6	1.1	< 0.0001**
It would be easy for me to find information using the video podcasts.	88	5.1	5	1.4	< 0.0001**

Ranking Scale Used: (1) Definitely Disagree, (2) Mostly Disagree, (3) Somewhat Disagree, (4) Neither Agree nor Disagree, (5) Somewhat Agree, (6) Mostly Agree, (7) Definitely Agree

* Significant

** Extremely Significant

Table 6

Technology Acceptance Model Survey of Video Acceptance: Student perceived usefulness

Question Items	**Count (n)**	**$\bar{x}$**	**Mode**	**SD**	**Wilcoxon signed rank test (P)**
Using the video podcasts would enhance my effectiveness in learning.	89	5.2	6	1.3	< 0.0001**
Using the video podcasts would improve my course performance.	89	5	5	1.2	< 0.0001**
Using the video podcasts would increase my productivity in my course work.	89	4.1	5	1.6	0.4311
I found the video podcasts useful.	89	5.4	6	1.2	< 0.0001**

Ranking Scale Used: (1) Definitely Disagree, (2) Mostly Disagree, (3) Somewhat Disagree, (4) Neither Agree nor Disagree, (5) Somewhat Agree, (6) Mostly Agree, (7) Definitely Agree

* Significant

** Extremely Significant

Table 7

Technology Acceptance Model Survey of Video Acceptance: Student attitude toward using

Question Items	**Count (n)**	$\bar{x}$	**Mode**	**SD**	**Wilcoxon signed rank test (P)**
I dislike the idea of using the video podcasts. (R)	88	2.8	2	1.4	< 0.0001**
I have a generally favorable attitude toward using the video podcasts.	89	5.2	6	1.3	< 0.0001**
I believe it is (would be) a good idea to use the video podcasts for my lab work.	89	5.3	5	1.2	< 0.0001**
Using the video podcasts is a foolish idea. (R)	89	2.3	1	1.4	< 0.0001**

Ranking Scale Used: (1) Definitely Disagree, (2) Mostly Disagree, (3) Somewhat Disagree, (4) Neither Agree nor Disagree, (5) Somewhat Agree, (6) Mostly Agree, (7) Definitely Agree

* Significant

** Extremely Significant

Table 8

Technology Acceptance Model Survey of Video Acceptance: Student intention to use

Question Items	**Count (n)**	$\bar{x}$	**Mode**	**SD**	**Wilcoxon signed rank test (P)**
I intend to use the video podcasts during the semester.	89	5.3	6	1.4	< 0.0001**
I will return to view the video podcasts often.	89	4.3	5	1.4	0.0273*
I intend to use the video podcasts frequently for my lab work.	89	4.7	5	1.3	< 0.0001**

Ranking Scale Used: (1) Definitely Disagree, (2) Mostly Disagree, (3) Somewhat Disagree, (4) Neither Agree nor Disagree, (5) Somewhat Agree, (6) Mostly Agree, (7) Definitely Agree

* Significant

** Extremely Significant

Q3-5: How, When, and Why are Students Using the Provided Video Podcasts?

The remaining three research questions were all addressed using data from the final survey, which specifically addressed laboratory video podcast use. Students reported that they were using the laboratory video podcasts almost exclusively while preparing for and executing the laboratory procedure. This was supported by their perceived usefulness of the videos for these purposes (Table 9) and provided open-ended responses (Table 10). For example, on the open-ended question "How helpful were the files you used in preparing for the laboratory?" 47% of students indicated that the video podcasts were of particular use in preparing for laboratory because they presented the procedural material in a visual format (Table 10). While the results of both laboratory-based questions were highly significant, the students' open-ended responses provided to the open-ended question "How helpful were the files in resolving questions during the laboratory?" were less elucidating as to why students felt this way than the ones provided for the open-ended question "How helpful were the files you used in preparing for the laboratory?" For example, on the open-ended question "How helpful were the files in resolving questions during the laboratory?" 26% of students indicated that the video podcasts were useful in previewing or clarifying steps in a procedure or in a technique during the laboratory and 11% of students indicated that the videos were generally useful (Table 10). The scale used for Likert items on this survey was: Not helpful at all (1), Not that helpful (2), Neutral/No Opinion (3), Somewhat helpful (4), and Extremely helpful (5).

Table 9

Student Perceived Usefulness of Videos for Specific Tasks

Question Items	Count (n)	$\bar{x}$	Mode	SD	Wilcoxon signed rank test (P)
1. How helpful were the files you used in preparing for the laboratory?	81	3.9	4	0.9	< 0.0001**
2. How helpful were the files in resolving questions during the laboratory?	81	3.4	4	1.0	0.0007**
3. How helpful were the files in preparing for quizzes?	79	3.0	3	1.1	0.7500
4. How helpful were the files in writing your lab reports?	80	3.0	3	1.1	0.8176

Ranking Scale Used: (1) Not helpful at all, (2) Not that helpful, (3) Neutral/No Opinion, (4) Somewhat helpful, (5) Extremely helpful

* Significant

** Extremely Significant

Table 10

Summary of Open-ended Responses corresponding to Items in Table 9 (n=81)

1. *How helpful were the files you used in preparing for the laboratory?*

Responses Given	Count	Percentage
Videos helped by presenting the procedural material in a visual format	38	47%
Comment about Echo360 Lecture capturing (not applicable) or unanswered	15	19%
Never or infrequently used the files, sometimes due to minor technical issues	7	9%
Generally useful	5	6%
Omissions of certain techniques or errors in the videos made them less useful	3	4%
Not helpful for my learning style or would rather ask TA	3	4%
Helpful with pre-lab completion	2	2%
It is faster to read, the videos dumb the class down	2	2%

2. How helpful were the files in resolving questions during the laboratory?

Responses Given	**Count**	**Percentage**
Useful in previewing or clarifying steps in a procedure or in a technique	21	26%
Never or infrequently used	16	20%
Unanswered/ No Comment	13	16%
It is easier/faster to ask the TA or I have questions that would not be in the videos	11	14%
The videos were generally useful	9	11%
Omissions of certain techniques or errors in the videos made them less useful	7	9%
Not my (learning) style	3	4%
Echo 360 Lecture Capturing comment	1	1%

3. How helpful were the files in preparing for quizzes?

Responses Given	**Count**	**Percentage**
Never or Infrequently used	30	37%
The materials in the lab videos was not applicable to the quizzes	26	32%
Echo 360 Lecture capturing comments	10	12%
The materials in the lab videos demonstrated some of the concepts on the quizzes	8	10%
Unanswered	7	9%
I was unsure how to study for this class	2	2%

4. How helpful were the files in writing your lab reports?

Responses Given	**Count**	**Percentage**
Never or infrequently used	34	42%
Useful for general review and reminder of what happened in lab	15	19%
The materials in the lab videos was not applicable to the lab report writing	14	17%
Echo 360 comment or off topic	11	14%
Unanswered or no comment	7	9%

CHAPTER 5: SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

Summary

The laboratory curriculum at this study site has been redesigned in an attempt to meet the charge of rethinking our curriculum as set forth by Hofstein and Lunetta in their seminal work *The laboratory in science education: Foundations for the twenty-first century* (2004). In an attempt to provide students with the immediacy and control over content that they are used to while also engaging them with the greater laboratory community, several social and multimedia technologies were employed side by side in the laboratory setting. While all of these technologies have purpose in the science laboratory, multimedia technologies, such as video podcasts, are of particular interest in an environment where there is both procedural and conceptual information to be mastered as the video format facilitates demonstration of processes. Demonstration can help make abstract text describing the procedural tasks more concrete and aid students in task completion (Snelson & Perkins, 2009). Video podcasts were developed to be used both as preparation tools and as JiTT and learning tools to help students address procedural issues quickly and easily, allowing them more time to consider the conceptual learning tasks.

However, it is important to note that technology must always be integrated into the curriculum, whether in the classroom or in the laboratory, with a purpose. According to Abt and Barry (2007), “students need to know not only *what* they are supposed to do, but *why* they are expected to do it and *how* it will enhance their learning if they are to engage with new mobile technologies" (Discussion section, para. 2). Despite being generally characterized as 'always plugged in,' the millennial generation does not engage with technology for the sake of technology in their learning (Abt & Barry, 2007). If students are not accepting of the technology provided and willing to engage with it, there is no way the technology can have an impact on their learning.

For the students in this study cohort, predominantly freshmen and sophomore Biology and Biotechnology Majors, this appears to be true. While 70% of students reported that they were familiar with the video podcasting technology, they appear to be most frequently engaged with and accepting of this technology in certain forms and for certain applications. The collected data indicated that while students often used this digital video technology for entertainment purposes (e.g., watching TV shows), they may not be as willing to readily engage with it as a classroom tool unless there is a degree of perceived usefulness to the tool. This is evidenced by their past behaviors. For example, fifty-five percent of students who had previously taken a class with audio or video files reported that they used the files never or not very often. This is a striking percentage especially when one considers that fifty-two percent of students who have taken advantage of these resources reported that these resources contributed to their learning more than somewhat and they indicated that access to such resources would be useful to them in their studies (Table 4). While this study was not designed to directly investigate student motivations behind past behaviors, the data does suggest that students may not be ready for engaging with educational materials in this manner. This is consistent with prior work such as Walls et al. (2010) who suggested that their "readiness findings or the lack thereof, suggest that students may not be as ready as we think they are for educational podcasting…" Despite this overall lack of "readiness," students reported that they do make use of the laboratory video podcasts for tasks where there is a perceived benefit to doing so.

In the case of video podcasts in the laboratory, students perceived benefits in two of the four task areas investigated. The four task areas chosen related both to laboratory as well as classroom-based tasks. As these videos were developed specifically to demonstrate procedural aspects of the laboratory, it was predicted, and the data supported, that students would find the videos useful for those task areas directly relating to the laboratory (Table 9). Students who used the laboratory video podcasts reported that they are most frequently using them to review the laboratory procedure. To this effect, on the open-ended question "How helpful were the files you used in preparing for the laboratory?" 47% of students indicated that the video podcasts were of particular use in preparing for laboratory because they presented the procedural material in a visual format that allowed them to understand the lab progression and visualize the procedure (Table 10). These comments were part of an interesting trend relating to student learning styles that was observed across open-ended student responses.

Throughout the surveys, several open-ended responses were provided in regards to learning styles. These comments came both from students who used the videos as well as from students who did not use the videos. These comments identified the videos as an alternative learning mode or style to that of text and they often indicated the degree to which video was part of their preferred learning mode.

Several students made direct reference to the compatibility level of these multimedia audio and video tools with their perceived learning style. For example, several students indicated that these multimedia resources were compatible with their learning style, noting “They provide both audio and visual ways to learn and enhance knowledge” and “Audio and video files present the information in a different form of media, which may make the information easier to understand.” This is in direct contrast to the few students who indicated that multimedia resources were not compatible with their learning style. These students made comments such as “[it is] Faster to read than to watch.”

Students also report that they are using the videos during the laboratory. While several students (14%) did indicate that asking the instructor or TA is faster and easier than watching the laboratory videos, 25% of student respondents did indicate that they used the videos to preview or clarify steps in a procedure or in a technique in the laboratory.

Students did not find the laboratory video podcasts useful when preparing for quizzes or writing lab reports. The Technology Acceptance Model predicts that perceived usefulness impacts usage and the findings in this study do conform to this model. Students reported that they did not use the provided laboratory video podcasts for tasks where there was no perceived usefulness (Table 9 and Table 10).

Conclusions

While this study sought to investigate the student use of video podcasts in the laboratory context, the data are confounded due to the fact that the class also used lecture capturing. Despite the fact that students were directed to answer questions based solely on their experiences with the video podcast provided for the laboratory not the Echo360 lecture captures, several students seem to discuss the two types of video files interchangeably in the open-ended questions. In many comments, it was very easy to identify those referring to Echo360 lecture capturing videos. These comments were coded as such and not used in the identification of usage trends. However, it is possible that some additional students who made more vague comments were actually considering the wrong set of resources therefore skewing the response data. This confounding factor makes it very hard to draw an absolute conclusion from the data.

However, it appears that the majority of students taking advantage of the provided video podcasting technologies do perceive a usage benefit as indicating by their high level of agreement with positive attitude towards using questions and intention to use questions on the TAM survey. Despite the confounding factors involved, it appears that the current methodology is generally well received and valued by some students as a learning resource (Table 7). Students did indicate an intention to use the videos moving forward (Table 8) in their studies.

Currently, there is no indication that the use of video podcasts in the laboratory as teaching methodology needs to be ceased or significantly modified. Student comments indicate that for those with visual and/or aural learning styles, multimedia resources, such as the videos provided here, may be of particular use in learning. Further study might be designed to remove the confounding influences present in this study and to further validate this conclusion.

Recommendations

Moving forward, it is recommended that this study be repeated with three modifications. First, survey rewording is suggested as an attempt to limit student confusion between the video podcast resources available to them in their course site. Second, survey coding to enable a richer investigation of the data set is suggested. Finally, the addition of a Learning Styles Inventory would aid in investigating the correlation between learning style preference and video podcast use adoption patterns.

First, in an effort to limit the confounding factor of student confusion regarding Echo360 lecture capturing versus the laboratory video podcasts, it is suggested that the surveys be modified to be more explicit. This included both the written survey directions as well as the survey questions. In the written survey directions, it would be helpful to provide a screen shot image of each of the types of video provided in the course website. Since the types of videos are easily distinguishable by their User Interface (UI), a graphic explicitly indicating which video podcast they should consider may be very useful. The text of the survey questions themselves should also be reworded to explicitly refer to the laboratory video podcasts. For example, the second questions on the Exit Survey on Video Podcast Use (adapted from Walls et al.) currently reads: “How helpful were the files you used in preparing for the laboratory?” While the instructions and previous question both refer to the laboratory video podcasts, the second question makes a vague reference to “files.” In order to clarify the intent of this question, the term “files” should be replaced to formulate a more explicit question, such as: “How helpful were the **provided laboratory video podcasts** you used in preparing for the laboratory?” More explicit questions should reduce the number of confounding responses provided to these questions where previously just the term “files” was used.

The second suggested modification would be the addition of survey identifiers. Survey identifiers would allow for an individual’s survey responses to be aggregated across all three surveys while maintaining respondent anonymity. This would enable additional data correlations to be completed. Correlations such as usage and gender, perceived use, and reported use per individual, as well as usage and level of initial technology acceptance could be made. These corollary analyses would add greater richness to the gathered dataset.

Lastly, the addition of a Learning Styles Inventory (LSI) is recommended. During the course of this study, several students noted in open-ended question responses that audio and video podcasting offers them a different mode for engaging with the materials. While most students who made these comments noted that the alternative mode helped, at least one student noted that they were not a visual learner and that was why they did not engage with the video podcasts. This indicates that the students appear to have identified that they have a perceived or actual learning modality preference and that student learning preference may have an impact on student usage of video podcasts in the laboratory environment. The addition of an LSI such as VARK (Leite, Svinicki, & Shi, 2010), in conjunction with survey coding, would allow the researcher to investigate the impact of student learning style on adoption.

REFERENCES

Abt, G., & Barry, T. (2007). The quantitative effect of students using podcasts in a first year undergraduate exercise physiology module. *Bioscience Education E-Journal, 10*(8) doi:10.3108/beej.10.8

Baxter, P., & Jack, S. (2008). Qualitative case study methodology: Study design and implementation for novice researchers. *The Qualitative Report, 13*(4), 544-559.

Burton Group. (2006). *Trends in social software.* No. ERS0604). Midvale,UT: Educause Center for Applied Research.

Bybee, R. (2000). Teaching science as inquiry. In J. Minstrel, & E. H. Van Zee (Eds.), *Inquiring into inquiry learning and teaching* (pp. 20-46). Washington, DC, USA: American Association for the Advancement of Science.

Carvalho-Knighton, K., & Keen-Rocha, L. (2007). Using technology to enhance the effectiveness of general chemistry laboratory courses. *Journal of Chemical Education, 84*(4), 727-730.

Chang, Y., & Chen, C. (2007). Experiences of adopting in-class blogs in the teaching of hands-on computer laboratory courses. *Seventh IEEE International Conference on*

Advanced Learning Technologies, 2007. ICALT 2007., 447-448. doi:10.1109/ICALT.2007.143

Clougherty, R., & Wells, M. (2008). Use of wikis in chemistry instruction for problem-based learning assignments: An example in instrumental analysis. *Journal of Chemical Education, 85*(10), 1446.

Colombo, M., & Colombo, P. (2007). Blogging to improve instruction in differentiated science classrooms. *Phi Delta Kappan, 89*(1), 60.

Coopers, M., & Kerns, T. (2006). Changing the laboratory: Effects of a laboratory course on students' attitudes and perceptions. *Journal of Chemical Education, 83*(9), 1356.

Cotton, K. (1991). *Computer-assisted instruction.* No. 10).School Improvement Research Series. Retrieved from http://www.nwrel.org/scpd/sirs/5/cu10.html

Crampton, A., Vanniasinkam, T., & Ragusa, A. T. (2008). Microbial vodcasting – supplementing laboratory time with vodcasts of key microbial skills. *UniServe Science Proceedings Visualisation,* The University of Sydney. 171-175.

Culp, K. M., Honey, M., & Mandinach, E. (2003). *A retrospective on twenty years of education technology policy.*U.S. Department of Education, Office of Educational Technology.

Dani, D., & Koenig, K. (2008). Technology and reform-based science education. *Theory into Practice, 47*(3), 204.

Dantas, A., & Kemm, R. (2008). A blended approach to active learning in a physiology laboratory-based subject facilitated by an e-learning component. *Advances in Physiology Education, 32*, 65.

Davis, F. D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of Information Technology. *MIS Quarterly, 13*(3), 319-340.

Davis, F. D. (1993). User acceptance of information technology: system characteristics, user perceptions and behavioral impacts. *International Journal of Man-Machine Studies, 38*(3), 475-487. doi:http://dx.doi.org/10.1006/imms.1993.1022

Diederen, J., Gruppen, H., Hartog, R., & Voragen, A. (2005). Design and evaluation of digital learning material to support acquisition of quantitative problem-solving skills within food chemistry. *Journal of Science Education & Technology, 14*(5/6), 495.

Elwood, S., Changchit, C., & Cutshall, R. (2006). Investigating Students' Perceptions on Laptop Initiative in Higher Education: An Extension of the Technology Acceptance Model. *Campus-Wide Information Systems, 23*(5), 336-349.

Fink, L. D. (2003). *Creating significant learning experiences : an integrated approach to designing college courses*. San Francisco, Calif.: Jossey-Bass.

Fishbein, M., & Ajzen, I. (1975). *Belief, Attitude, Intention, and Behavior: An Introduction to Theory and Research*. Reading, MA: Addison-Wesley. Retrieved from http://www.people.umass.edu/aizen/f&a1975.html

Gao, Y. (2005). Applying the Technology Acceptance Model to educational hypermedia: a field study. *Journal of Educational Multimedia and Hypermedia, 14*(3), 237-247.

Gee, J. P. (2003). What video games have to teach us about learning and literacy. *Computers in Entertainment, 1*(1), 20.

Gray, D. (2004). *Doing research in the real world* (First Edition ed.). London, England: Sage Publications.

Gribbins, M. (2007). The perceived usefulness of podcasting in higher education: A survey of students' attitudes and intention to use. *MWAIS 2007 Proceedings, Paper 6*

Hofstein, A., & Lunetta, V. N. (2004). The laboratory in science education: Foundations for the twenty-first century. *Science Education, 88*(1), 28-54. doi:10.1002/sce.10106

Honey, K. (2008). Science rides the online wave. *The Journal of Clinical Investigation, 118*(6), 1976-1976.

Hu, P. J., Chau, P. Y. K., Sheng, O. R. L., & Tam, K. Y. (1999). Examining the technology acceptance model using physician acceptance of telemedicine technology. *Journal of Management Information Systems, 16*(2), 91-112.

Huang, W. D., Yoo, S. J., & Choi, J. (2008). Correlating college students' learning styles and how they use Web 2.0 applications for learning. *Paper Presented at the World Conference on E-Learning in Corporate, Government, Healthcare, and Higher Education (ELEARN) 2008,* , 2752-2759.

Hunter, A., Caron, J., Rulfs, J., & Buckholt, M. (2010). Using a classroom response system (CRS) for real time data display and analysis in introductory biology labs. *Journal of College Science Teaching, 40*(2), 19-25.

Intel Corporation. (2005). *Moore's Law.*Intel. Retrieved from http://download.intel.com/museum/Moores_Law/Printed_Materials/Moores_Law_2pg.pdf

Joosten, S. A., Sijpkens, Y. W., van Ham, V., Trouw, L. A., van der Vlag, J., van den Heuvel, B., van Kooten, C., et al. (2005). Antibody response against the glomerular basement membrane protein agrin in patients with transplant glomerulopathy. *American Journal of Transplantation, 5*(2), 383-393. doi:10.1111/j.1600-6143.2005.00690.x

Keengwe, J., Onchwari, G., & Wachira, P. (2008a). The use of computer tools to support meaningful learning. *Association for the Advancement of Computing in Education Journal, 16*(1), 77-92.

Keengwe, J., Onchwari, G., & Wachira, P. (2008b). Computer technology integration and student learning: Barriers and promise. *Journal of Science Education & Technology, 17*(6), 560.

Kemp, P. K., Myers, C. E., Campbell, M. R., & Pratt, A. P. (2010). Student perceptions and the effectiveness of podcasting in an Associate Degree Nursing program. *Teaching and Learning in Nursing, 5*(3), 111-114. doi:DOI: 10.1016/j.teln.2010.01.006

Kohler, R. E. (2008). Lab history. *ISIS: Journal of the History of Science in Society, 99*(4), 761.

Kuhn, T. (1962). *The Structure of Scientific Revolutions* (3rd edition ed.). Chicago: University Of Chicago Press.

Kulik, J. A. (1994). Meta-analytic studies of findings on computer-based instruction. In E. L. Baker, & H. F. J. O'Neil (Eds.), *Technology assessment in education and training* (pp. 9-33). Hillsdale, NJ: Lawrence Erlbaum.

Kulik, J. A. (2003). *Effects of using instructional technology in elementary and secondary schools: What controlled evaluation studies say.* No. P10446.001). Arlington, VA: SRI International. Retrieved from http://www.sri.com/policy/csted/reports/sandt/it/Kulik_ITinK-12_Main_Report.pdf

Landry, B., Griffeth, R., & Hartman, S. (2006). Measuring Student Perceptions of Blackboard Using the Technology Acceptance Model. *Decision Sciences Journal of Innovative Education, 4*(1), 87-99. doi:10.1111/j.1540-4609.2006.00103.x

Lederer, A. L., Maupin, D. J., Sena, M. P., & Zhuang, Y. (2000). The technology acceptance model and the World Wide Web. *Decision Support Systems, 29*(3), 269-282. doi:DOI: 10.1016/S0167-9236(00)00076-2

Lee, M., Chan, A., & McLoughlin, C. (2006). Students as producers: second year students' experiences as podcasters of content for first year undergraduates.

Information Technology Based Higher Education and Training, 2006. ITHET '06. 7th International Conference on, , 832-841. doi:10.1109/ITHET.2006.339707

Lee, H. P. (2002). Comparison between traditional and web-based interactive manuals for laboratory-based subjects. *International Journal of Mechanical Engineering Education, 30*(4), 307.

Lee, Y., Kozar, K. A., & Larsen, K. R. T. (2003). The technology acceptance model: Past, present, and future. *Communications of the Association for Information Systems,* (1), 752-780. Retrieved from http://aisel.aisnet.org/cais/vol12/iss1/50

Leedy, P., & Ormrod, J. (2009). *Practical Research: Planning and Design* (Ninth Edition ed.). Upper Saddle River, NJ: Prentice Hall.

Leite, W. L., Svinicki, M., & Shi, Y. (2010). Attempted Validation of the Scores of the VARK: Learning Styles Inventory With Multitrait–Multimethod Confirmatory Factor Analysis Models. *Educational and Psychological Measurement, 70*(2), 323-339. doi:10.1177/0013164409344507

Liu, J., Thorndike Pysarchik, D., & Taylor, W. W. (2002). Peer Review in the Classroom. *Bioscience, 52*(9), 824-829. Retrieved from http://www.jstor.org/stable/1314171

Moore, G. M. (1965). Cramming more components onto integrated circuits. *Electronics, 38*(8) Retrieved from http://download.intel.com/museum/Moores_Law/Articles-Press_Releases/Gordon_Moore_1965_Article.pdf

Motulsky, H. (2010). *Intuitive Biostatistics: A Nonmathematical Guide to Statistical Thinking* (Second Edition ed.) Oxford University Press.

Nagy-Shadman, E., & Desrochers, C. (2008). Student response technology: Empirically grounded or just a gimmick?. *International Journal of Science Education, 30*(15), 2023.

Niedziela, J., Fu, W., Harvey, P., Marr, G., Schoefer, V., & Satogata, T. (2007). Dynamic collaborative documentation at the Brookhaven National Laboratory Collider-Accelerator Department. *Particle Accelerator Conference, 2007. PAC. IEEE,* , 658-660. doi:10.1109/PAC.2007.4440311

Pearson, H. (2006). Online methods share insider tricks. *Nature, 441*(7094), 678.

Peck, K. L., & Dorricott, D. (1994). Why use technology? *Educational Leadership, 51*(7), 11-14.

Prensky, M. (2008). Turning on the lights. *Educational Leadership, 65*(6), 40-45.

Richardson, W. (2008). Footprints in the digital age. *Educational Leadership, 66*(3), 16-19.

Saeed, N., Yang, Y., & Sinnappan, S. (2009). Effects of cognitive style on user acceptance of blogs and podcasts. *ICALT '09: Proceedings of the 2009 Ninth IEEE International Conference on Advanced Learning Technologies,* 293-297. doi:10.1109/ICALT.2009.83

Saettler, L. P. (2004). *The evolution of American educational technology* (2nd ed.). Greenwich, CT: Information Age Publishing.

Selwyn, N., & Grant, L. (2009). Researching the realities of social software use - an introduction. *Learning, Media, & Technology, 34*(2), 79.

Shiland, T. (1999). Constructivism: The implications for laboratory work. *Journal of Chemical Education, 6*(1), 107-110.

Smith, R., Clark, T., & Blomeyer, R. L. (2005). *A synthesis of new research on K–12 online learning* . Naperville, IL: Learning Point Associates.

Snelson, C. (2008). Web-based video in education: Possibilities and pitfalls. *TCC Worldwide Online Conference,* , 214-221. Retrieved from http://etec.hawaii.edu/proceedings/2008/Snelson2008.pdf

Snelson, C., & Perkins, R. (2009). From silent film to YouTube[tm]: tracing the historical roots of motion picture technologies in education. *Journal of Visual Literacy, 28*(1), 1-27.

Strommen, E. F., & Lincoln, B. (1992). Constructivism, technology, and the future of classroom learning. *Education and Urban Society, 24*(4), 466-476.

Trelease, R. B. (2008). Diffusion of innovations: Smartphones and wireless anatomy learning resources. *Anatomical Sciences Education, 1*(6), 233-239. doi:10.1002/ase.58

U.S. Department of Education, Office of Educational Technology. (2004). *Toward a new golden age in American education: How the internet, the law and today's students are revolutionizing expectations.* Washington, D.C.: U.S. Department of Education. Retrieved from http://www.ed.gov/about/offices/list/os/technology/plan/2004/plan.pdf

Usluel, Y., & Mazman, S. (2009). Adoption of Web 2.0 tools in distance education. *Procedia - Social and Behavioral Sciences, 1*(1), 818-823. doi:DOI: 10.1016/j.sbspro.2009.01.146

Venkatesh, V., & Davis, F. D. (2000). A theoretical extension of the Technology Acceptance Model: Four longitudinal field studies. *Management Science, 46*(2), 186-204. doi:10.1287/mnsc.46.2.186.11926

Walls, S. M., Kucsera, J. V., Walker, J. D., Acee, T. W., McVaugh, N. K., & Robinson, D. H. (2010). Podcasting in education: Are students as ready and eager as we think they are? *Computers & Education, 54*(2), 371-378. doi:DOI: 10.1016/j.compedu.2009.08.018

WPI Division of Enrollment Management. (2010). *WPI 2010 Fact Book: Undergraduate & Graduate Student Enrollment Information* WPI. Retrieved from http://www.wpi.edu/Images/CMS/Bartlett/Factbook_2010(1).pdf

Zivkovic, B., Bradley, J., Stemwedel, J., Edwards, P., & Vaughan, K. T. L. (2007). Opening science to all: Implications of blogs and wikis for social and scholarly scientific communication. *Proceedings of the American Society for Information Science and Technology, 44*(1), 1-3.

APPENDIX A

Institutional Review Board (IRB) Protocol Approval

100 Institute Road
Worcester, MA 01609-2280, USA
508-831-5000, Fax: 508-831-6090
www.wpi.edu

Worcester Polytechnic Institute IRB #1
IRB 00007374

12 August 2010
File:10-098

Worcester Polytechnic Institute
100 Institute Road
Worcester, MA 01609

Re: IRB Application for Exemption 10-098 "Technology in the Science Laboratory: Student Use and Acceptance of Video Podcasts in the Laboratory"

Dear Ms. Caron,

The WPI Institutional Review Committee (IRB) has reviewed the materials submitted in regards to the above mentioned study and has determined that this research is exempt from further IRB review and supervision under 45 CFR 46.101(b)(1): "**Research conducted in established or commonly accepted educational settings, involving normal educational practices, such as (i) research on regular and special education instructional strategies, or (ii) research on the effectiveness of or the comparison among instructional techniques, curricula, or classroom management methods.**"

This exemption covers any research and data collected under your protocol beginning 12 August 2010, unless terminated sooner (in writing) by yourself or the WPI IRB. Amendments or changes to the research that might alter this specific exemption must be submitted to the WPI IRB for review and may require a full IRB application in order for the research to continue.

Please contact the undersigned if you have any questions about the terms of this exemption.

Thank you for your cooperation with the WPI IRB.

Sincerely,

Kent Rissmiller

Kent Rissmiller
WPI IRB Chair

APPENDIX B

Informed Consent

Students will be informed of the nature of the study prior to beginning each survey. This information will be presented before beginning a survey so that students may opt out of participation if they so choose.

Informed Consent Survey 1

You are being asked to participate in a research study entitled Technology in the Science Laboratory: Student Use and Acceptance of Video Podcasts in the Laboratory. The following is the first survey in a three part survey methodology designed to study the impact of supplementary podcasts on students' acceptance and usage of video podcasts in the laboratory environment. Your participation in this study is anonymous and entirely voluntary. This survey is not required as part of your course and you may choose to exit this survey at any time with no penalty to you or your grade.

Informed Consent Survey 2

You are being asked to participate in a research study entitled Technology in the Science Laboratory: Student Use and Acceptance of Video Podcasts in the Laboratory. The following is the second survey in a three part survey methodology designed to study the impact of supplementary podcasts on students' acceptance and usage of video podcasts in the laboratory environment. Your participation in this study is anonymous and entirely voluntary. This survey is not required as part of your course and you may choose to exit this survey at any time with no penalty to you or your grade.

Informed Consent Survey 3

You are being asked to participate in a research study entitled Technology in the Science Laboratory: Student Use and Acceptance of Video Podcasts in the Laboratory. The following is the third survey in a three part survey methodology designed to study the impact of supplementary podcasts on students' acceptance and usage of video podcasts in the laboratory environment. Your participation in this study is anonymous and entirely voluntary. This survey is not required as part of your course and you may choose to exit this survey at any time with no penalty to you or your grade.

APPENDIX C

Pre-course Survey of Demographics and Familiarity with Podcasting

(Adapted from Walls et al., 2010)

Demographics

I am a:

- o Freshman
- o Sophomore
- o Junior
- o Senior
- o Other

I am:

- o Male
- o Female
- o Would prefer not to specify

My Major is: ___________

I have previously taken a 2900 series lab course which used video podcasting

- o Yes
- o No

Familiarity with Podcasting

How frequently do you engage in any of the following activities? Check one column per row. (The scale for the following items is: (0) Never (1) Less than once per month (2) At least monthly but not weekly (3) At least weekly but not daily (4) Once or twice a day (5) Three or more times a day)

a. Listen to music
b. Listen to recorded books
c. Listen to speeches/interviews not related to your college courses
d. Listen to class lectures
e. Listen to other information relevant to your college courses
f. Listen to other audio (describe)
g. Watch television shows
h. Watch short video clips
i. Watch movies
j. Watch class lectures
k. Watch other information related to my college courses
l. Watch other video (describe)

Are you familiar with podcasting?

- o Yes
- o No

How knowledgeable are you with video podcasting/podcast technology?

- Not at all knowledgeable
- A little knowledgeable
- Neutral
- Fairly knowledgeable
- Very knowledgeable

How many classes have you had that provide audio or video files (e.g., class lectures or class-related materials) that you could access and use on a computer?

- None
- One
- Two
- Three
- Four
- Five
- 6–10
- 11–15
- More than 15

How many classes have you had that provide audio or video files (e.g., class lectures or class-related materials) that you could download and use on your computer or mp3 player?

- None
- One
- Two
- Three
- Four
- Five
- 6–10
- 11–15
- More than 15

If you have had a class or classes that use mp3 or video files, to what extent do you believe that you used them? Circle one.

- Not applicable
- Never
- Not very often
- Occasionally
- Fairly often
- Very often

If you have had a class or classes that use mp3 or video files and you utilized them to any extent, how much did that resource contribute to your learning in that class?

- Not applicable
- Did not utilize

- o Really did not contribute
- o A little bit
- o Somewhat
- o Quite a bit
- o A lot

If you have had a class or classes that use mp3 or video files and you utilized them to any extent, how satisfied overall were you with them as a class resource?

- o Not applicable
- o Did not utilize
- o Really did not contribute
- o A little bit
- o Somewhat
- o Quite a bit
- o A lot

What was the best thing about or biggest strength of the mp3 or video files as a class resource? (open-ended)

What was the worst thing about or biggest limitation of the mp3 or video files as a class resource? (open-ended)

In general, do you think it would be useful for you to have access to audio or video files of class resources? Check all that apply.

- o Class lectures
- o Overviews of difficult concepts
- o Demonstrations of laboratory procedures
- o Guest speakers
- o Lectures and slides integrated together
- o Supplemental material from experts or authors in the field

If mp3 or video files were offered as a class resource, during what activities or circumstances would you be most likely to use them? (Check all that apply.)

- o On a computer while studying
- o On a portable device while studying
- o While traveling or commuting (on the bus, in a car, on a bike, or on foot)
- o While exercising
- o While eating
- o During down time (while waiting for a ride, in between classes, before an appointment)
- o Some other activity or circumstance (please describe)

How might using podcasting (audio and video files) as a class resource be beneficial to you? (open-ended)

How might using podcasting (audio and video files) as a class resource NOT be beneficial to you? (open-ended)

APPENDIX D

Technology Acceptance Model Survey Opinion Survey of Laboratory Video Podcasts (adapted from Gao, 2005)

Please circle the number that best indicates your agreement or disagreement with each statement.

	Question Category: Perceived Ease of Use	Definitely Disagree				Definitely Agree		
		1	2	3	4	5	6	7
	I found the video podcasts easy to use.							
	Learning to use the video podcasts would be easy for me.							
	My interaction with the video podcasts was clear and understandable.							
	It would be easy for me to find information using the video podcasts.							
	Question Category: Perceived Usefulness	Definitely Disagree				Definitely Agree		
		1	2	3	4	5	6	7
	Using the video podcasts would enhance my effectiveness in learning.							
	Using the video podcasts would improve my course performance.							
	Using the video podcasts would increase my productivity in my course work.							
	I found the video podcasts useful.							
	Question Category: Attitude toward Using	Definitely Disagree				Definitely Agree		
		1	2	3	4	5	6	7
	I dislike the idea of using the video podcasts. (R)							
	I have a generally favorable attitude toward using the video podcasts.							
	I believe it is (would be) a good idea to use the video podcasts for my lab work.							
	Using the video podcasts is a foolish idea. (R)							
	Question Category: Intention to Use	Definitely Disagree				Definitely Agree		
		1	2	3	4	5	6	7
	I intend to use the video podcasts during the semester.							
	I will return to view the video podcasts often.							
	I intent to use the video podcasts frequently for my lab work.							

Notes:
Items will be presented in randomized fashion to participants using the randomization function in the Blackboard Survey Manager.
* R - reversed item.

APPENDIX E

Exit Survey on Video Podcast Use (Adapted from Walls et al., 2010)

1. Were you able to listen/view the provided laboratory video podcasts on your class website?

- No. . .never attempted
- No. . .attempted but was never successful
- Yes. . .but successful after more than one attempt
- Yes. . .successful on first attempt

2. How helpful were the files you used in preparing for the laboratory?

- Not helpful at all
- Not that helpful
- Neutral/No Opinion
- Somewhat helpful
- Extremely helpful

3. Given your responses on question 2, please briefly describe the reasons for your responses. (Open-ended)

4. How helpful were the files in resolving questions during the laboratory?

- Not helpful at all
- Not that helpful
- Neutral/No Opinion
- Somewhat helpful
- Extremely helpful

5. Given your responses on question 4, please briefly describe the reasons for your responses. (Open-ended)

6. How helpful were the files in preparing for quizzes?

- Not helpful at all
- Not that helpful
- Neutral/No Opinion
- Somewhat helpful
- Extremely helpful

7. Given your responses on question 6, please briefly describe the reasons for your responses. (Open-ended)

8. How helpful were the files in writing your lab reports?

- Not helpful at all
- Not that helpful
- Neutral/No Opinion
- Somewhat helpful
- Extremely helpful

9. Given your responses on question 8, please briefly describe the reasons for your responses. (Open-ended)

10. Please provide any other feedback regarding the laboratory video podcasts and/or your uses of them described in the questions above. (Open-ended)

APPENDIX F

Summary of Quantitative Survey Data

Pre-course Survey of Demographics and Familiarity with Podcasting

Demographics

I am a:

Response Choices	**Count (n)**	**Percent**
Freshman	4	
Sophomore	47	
Junior	18	
Senior	18	
Other	1	

I am:

Response Choices	**Count (n)**	**Percent**
Male	30	44%
Female	58	66%

My Major is:

Response Choices	**Count (n)**	**Percent**
Biology and Biotechnology (BBT)	55	63%
Chemistry and Biochemistry (CBC)	11	13%
Chemical Engineering (ChE)	2	2%
Biomedical Engineering (BME)	12	14%
Mechanical Engineering (ME)	1	1%

I have previously taken a 2900 series lab course which used video podcasting		
Response Choices	**Count (n)**	**Percent**
Yes	41	47
No	47	53

Frequency of Student Engagement in Activities

Listening to music		
Response Choices	**Count (n)**	**Percent**
Three or more times a day	39	44%
Once or twice a day	27	31%
At least weekly, but not daily	16	18%
At least monthly, but not weekly	5	6%
Less than once per month	1	1%
Never	0	0%
Unanswered	0	0%

Listening to recorded books

Response Choices	Count (n)	Percent
Three or more times a day	0	0%
Once or twice a day	1	1%
At least weekly, but not daily	1	1%
At least monthly, but not weekly	6	7%
Less than once per month	16	18%
Never	64	73%
Unanswered	0	0%

Listening to speeches/interviews not related to your college courses

Response Choices	Count (n)	Percent
Three or more times a day	0	0%
Once or twice a day	0	0%
At least weekly, but not daily	13	15%
At least monthly, but not weekly	19	22%
Less than once per month	23	26%
Never	33	38%
Unanswered	0	0%

Listening to class lectures

Response Choices	**Count (n)**	**Percent**
Three or more times a day	2	2%
Once or twice a day	13	15%
At least weekly, but not daily	24	27%
At least monthly, but not weekly	14	16%
Less than once per month	25	28%
Never	9	10%
Unanswered	1	1%

Listening to other information relevant to your college courses

Response Choices	**Count (n)**	**Percent**
Three or more times a day	1	1%
Once or twice a day	5	6%
At least weekly, but not daily	26	30%
At least monthly, but not weekly	19	22%
Less than once per month	19	22%
Never	18	20%
Unanswered	0	0%

Listening to other audio

Response Choices	**Count (n)**	**Percent**
Three or more times a day	3	3%
Once or twice a day	5	6%
At least weekly, but not daily	9	10%
At least monthly, but not weekly	7	8%
Less than once per month	9	10%
Never	55	63%
Unanswered	0	0%

If you listen to other audio, what types of other audio do you listen to? (please describe)

Responses Received	**Count (n)**	**Percent**
Music	7	-
News/NPR/Talk Radio	6	-
TV Shows	4	-
Podcasts	3	-
Sports	2	-
YouTube	2	-
Radio	1	-

Watching television shows

Response Choices	Count (n)	Percent
Three or more times a day	8	9%
Once or twice a day	34	39%
At least weekly, but not daily	37	42%
At least monthly, but not weekly	1	1%
Less than once per month	6	7%
Never	2	2%
Unanswered	0	0%

Watching short video clips

Response Choices	Count (n)	Percent
Three or more times a day	9	10%
Once or twice a day	19	22%
At least weekly, but not daily	34	39%
At least monthly, but not weekly	18	20%
Less than once per month	6	7%
Never	1	1%
Unanswered	1	1%

Watching movies

Response Choices	**Count (n)**	**Percent**
Three or more times a day	1	1%
Once or twice a day	5	6%
At least weekly, but not daily	45	51%
At least monthly, but not weekly	32	36%
Less than once per month	5	6%
Never	0	0%
Unanswered	0	0%

Watching class lectures

Response Choices	**Count (n)**	**Percent**
Three or more times a day	0	0%
Once or twice a day	5	6%
At least weekly, but not daily	22	25%
At least monthly, but not weekly	24	27%
Less than once per month	22	25%
Never	15	17%
Unanswered	0	0%

Watching other information related to my college courses

Response Choices	**Count (n)**	**Percent**
Three or more times a day	0	0%
Once or twice a day	3	3%
At least weekly, but not daily	16	18%
At least monthly, but not weekly	29	33%
Less than once per month	19	22%
Never	21	24%
Unanswered	0	0%

Watching other video

Response Choices	**Count (n)**	**Percent**
Three or more times a day	5	6%
Once or twice a day	6	7%
At least weekly, but not daily	20	23%
At least monthly, but not weekly	12	14%
Less than once per month	22	25%
Never	22	25%
Unanswered	1	1%

Are you familiar with podcasting?

Response Choices	Count (n)	Percent
Yes	62	70%
No	26	30%

How knowledgeable are you with video podcasting/podcast technology?

Response Choices	Count (n)	Percent
Not at all knowledgeable	22	25%
A little knowledgeable	33	38%
Neutral	22	25%
Fairly knowledgeable	11	13%
Very knowledgeable	0	0%

How many classes have you had that provide audio or video files (e.g., class lectures or class-related materials) that you could access and use on a computer?

Response Choices	**Count (n)**	**Percent**
None	1	1%
One	7	8%
Two	18	20%
Three	22	25%
Four	10	11%
Five	12	14%
6–10	16	18%
11–15	2	2%
More than 15	0	0%

How many classes have you had that provide audio or video files (e.g., class lectures or class-related materials) that you could download and use on your computer or mp3 player?

Response Choices	Count (n)	Percent
None	13	15%
One	15	17%
Two	15	17%
Three	21	24%
Four	3	3%
Five	4	5%
6–10	14	16%
11–15	2	2%
More than 15	0	0%

If you have had a class or classes that use mp3 or video files, to what extent do you believe that you used them?

Response Choices	Count (n)	Percent
Not applicable	14	16%
Never	12	14%
Not very often	29	33%
Occasionally	20	23%
Fairly often	11	13%
Very often	2	2%

If you have had a class or classes that use mp3 or video files and you utilized them to any extent, how much did that resource contribute to your learning in that class?

Response Choices	**Count (n)**	**Percent**
Not applicable	21	24%
Did not utilize	11	13%
Really did not contribute	7	8%
A little bit	20	23%
Somewhat	11	13%
Quite a bit	15	17%
A lot	3	3%

If you have had a class or classes that use mp3 or video files and you utilized them to any extent, how satisfied overall were you with them as a class resource?

Response Choices	**Count (n)**	**Percent**
Not applicable	23	26%
Did not utilize	10	11%
Really did not contribute	8	9%
A little bit	13	15%
Somewhat	13	15%
Quite a bit	14	16%
A lot	5	6%
Unanswered	2	2%

What was the best thing about or biggest strength of the mp3 or video files as a class resource?

Responses Received	**Count (n)**	**Percent**
Review reasons given: recap, exam, increasing comprehension of difficult area	29	-
Access to classes missed due to illness, skipping, etc.	12	-
Level of access (e.g., "can access them whenever you like")	8	-
Taking notes or Refining notes taken during lecture	7	-
Reviewing demonstrations to increase comprehension (lab based or problem based)	6	-
Different mode of learning	1	-

What was the worst thing about or biggest limitation of the mp3 or video files as a class resource?		
Responses Received	**Count (n)**	**Percent**
Technical difficulties	14	-
Video/ audio is too long so it is hard to find the section you want to review	5	-
Limited formats (Does not capture video of classroom so gesticulations are not recorded or audio only)	5	-
Files are too large (storage space issues as well as length of time to download)	3	-
Encourages some students to skip	3	-
Redundant resource	2	
Cannot ask questions while listening to capture	2	-
Becomes boring	2	
Time it took to access the files was prohibitive	1	-

In general, do you think it would be useful for you to have access to audio or video files of class resources?

Responses Choices	**Count (n)**	**Percent**
Class lectures	76	86%
Overviews of difficult concepts	72	82%
Demonstrations of laboratory procedures	71	81%
Guest speakers	44	50%
Lectures and slides integrated together	71	81%
Supplemental material from experts or authors in the field	36	41%

If mp3 or video files were offered as a class resource, during what activities or circumstances would you be most likely to use them?		
Response Choices	**Count (n)**	**Percent**
On a computer while studying	80	91%
	18	20%
On a portable device while studying	16	18%
While traveling or commuting (on the bus, in a car, on a bike, or on foot)	13	15%
While exercising	15	17%
While eating	26	30%
During down time (while waiting for a ride, in between classes, before an appointment)	10	11%

How might using podcasting (audio and video files) as a class resource be beneficial to you? (open-ended)

Responses Received	**Count (n)**	**Percent**
Review of Materials (e.g., note taking or increasing comprehension)	35	-
Catching up on missed classes (almost all noted in case of illness in their answer)	10	-
Time management tool	6	-
Would not or do not use	6	-
Unfettered access / portability	5	-
Different Mode for presentation or materials	4	-
Depends on how it is used	1	-

How might using podcasting (audio and video files) as a class resource NOT be beneficial to you? (open-ended)

Responses Received	**Count (n)**	**Percent**
Technology access or technology difficulties	11	-
I go to class I do not need this or I do not/would not use	10	-
Encourages skipping	10	
Can only help	9	
Hard to find time to use these resources	6	
The technology is hard to use or induces distractions that detract from the class	6	-
Can cause further confusion if there is a poor explanation or contradiction included in the provided resource	5	-
Can be overwhelming	2	-
Cannot ask questions while watching	2	-

Technology Acceptance Model - Opinion Survey of Laboratory Video Podcasts

Where the following scale was used:

Definitely Disagree	1
Mostly Disagree	2
Somewhat Disagree	3
Neither Agree nor Disagree	4
Somewhat Agree	5
Mostly Agree	6
Definitely Agree	7

Questions:	Answer Choices:	Raw Count:	Percentages:
I found the video podcasts easy to use.	Definitely Disagree	1	1%
	Mostly Disagree	3	3%
	Somewhat Disagree	5	6%
	Neither Agree nor Disagree	9	10%
	Somewhat Agree	16	18%
	Mostly Agree	38	43%
	Definitely Agree	17	19%
	Total:	89	
	Calculated value	5.45	
Learning to use the video podcasts would be easy for me.	Definitely Disagree	0	0%
	Mostly Disagree	0	0%
	Somewhat Disagree	3	3%
	Neither Agree nor Disagree	9	10%
	Somewhat Agree	20	22%
	Mostly Agree	29	33%
	Definitely Agree	28	31%
	Total:	89	
	Calculated value	5.79	

Questions:	Answer Choices:	Raw Count:	Percentages:
My interaction with the video podcasts was clear and understandable.	Definitely Disagree	0	0%
	Mostly Disagree	2	2%
	Somewhat Disagree	2	2%
	Neither Agree nor Disagree	10	11%
	Somewhat Agree	19	21%
	Mostly Agree	37	42%
	Definitely Agree	19	21%
	Total:	89	
	Calculated value	5.62	
It would be easy for me to find information using the video podcasts.	Definitely Disagree	0	0%
	Mostly Disagree	3	3%
	Somewhat Disagree	12	14%
	Neither Agree nor Disagree	7	8%
	Somewhat Agree	28	32%
	Mostly Agree	24	27%
	Definitely Agree	14	16%
	Unanswered	1	
	Total:	89	
	Calculated value	5.14	
Using the video podcasts would enhance my effectiveness in learning.	Definitely Disagree	0	0%
	Mostly Disagree	5	6%
	Somewhat Disagree	4	4%
	Neither Agree nor Disagree	15	17%
	Somewhat Agree	26	29%
	Mostly Agree	26	29%
	Definitely Agree	13	15%
	Total:	89	
	Calculated value	5.16	

Questions:	Answer Choices:	Raw Count:	Percentages:
Using the video podcasts would improve my course performance.	Definitely Disagree	0	0%
	Mostly Disagree	4	4%
	Somewhat Disagree	5	6%
	Neither Agree nor Disagree	20	22%
	Somewhat Agree	27	30%
	Mostly Agree	24	27%
	Definitely Agree	9	10%
	Total:	89	
	Calculated value	5.00	
Using the video podcasts would increase my productivity in my course work.	Definitely Disagree	10	11%
	Mostly Disagree	4	4%
	Somewhat Disagree	13	15%
	Neither Agree nor Disagree	16	18%
	Somewhat Agree	29	33%
	Mostly Agree	17	19%
	Definitely Agree	0	0%
	Total:	89	
	Calculated value	4.13	
I found the video podcasts useful.	Definitely Disagree	0	0%
	Mostly Disagree	1	1%
	Somewhat Disagree	4	4%
	Neither Agree nor Disagree	15	17%
	Somewhat Agree	23	26%
	Mostly Agree	27	30%
	Definitely Agree	19	21%
	Total:	89	
	Calculated value	5.44	

Questions:	Answer Choices:	Raw Count:	Percentages:
I dislike the idea of using the video podcasts.	Definitely Disagree	16	18%
	Mostly Disagree	26	30%
	Somewhat Disagree	19	22%
	Neither Agree nor Disagree	13	15%
	Somewhat Agree	12	14%
	Mostly Agree	1	1%
	Definitely Agree	1	1%
	Unanswered	1	
	Total:	89	
	Calculated value	2.84	
I have a generally favorable attitude toward using the video podcasts.	Definitely Disagree	0	0%
	Mostly Disagree	1	1%
	Somewhat Disagree	11	12%
	Neither Agree nor Disagree	12	13%
	Somewhat Agree	22	25%
	Mostly Agree	29	33%
	Definitely Agree	14	16%
	Total:	89	
	Calculated value	5.22	
I believe it is (would be) a good idea to use the video podcasts for my lab work.	Definitely Disagree	0	0%
	Mostly Disagree	1	1%
	Somewhat Disagree	7	8%
	Neither Agree nor Disagree	13	15%
	Somewhat Agree	28	31%
	Mostly Agree	25	28%
	Definitely Agree	15	17%
	Total:	89	
	Calculated value	5.28	

Questions:	Answer Choices:	Raw Count:	Percentages:
Using the video podcasts is a foolish idea.	Definitely Disagree	34	38%
	Mostly Disagree	22	25%
	Somewhat Disagree	13	15%
	Neither Agree nor Disagree	13	15%
	Somewhat Agree	5	6%
	Mostly Agree	1	1%
	Definitely Agree	1	1%
	Total:	89	
	Calculated value	2.33	
I intend to use the video podcasts during the semester.	Definitely Disagree	1	1%
	Mostly Disagree	4	4%
	Somewhat Disagree	5	6%
	Neither Agree nor Disagree	10	11%
	Somewhat Agree	22	25%
	Mostly Agree	31	35%
	Definitely Agree	16	18%
	Total:	89	
	Calculated value	5.30	
I will return to view the video podcasts often.	Definitely Disagree	1	1%
	Mostly Disagree	7	8%
	Somewhat Disagree	18	20%
	Neither Agree nor Disagree	19	21%
	Somewhat Agree	28	31%
	Mostly Agree	11	12%
	Definitely Agree	5	6%
	Total:	89	
	Calculated value	4.34	

Questions:	Answer Choices:	Raw Count:	Percentages:
I intend to use the video podcasts frequently for my lab work.	Definitely Disagree	1	1%
	Mostly Disagree	4	4%
	Somewhat Disagree	11	12%
	Neither Agree nor Disagree	20	22%
	Somewhat Agree	27	30%
	Mostly Agree	18	20%
	Definitely Agree	8	9%
	Total:	89	
	Calculated value	4.73	

Exit Survey on Video Podcast Use

Where the following scale was used:

Not helpful at all	1
Not that helpful	2
Neutral/No Opinion	3
Somewhat helpful	4
Extremely helpful	5

Descriptive Statistic:	**Questions:**			
	How helpful were the files you used in preparing for the laboratory?	**How helpful were the files in resolving questions during the laboratory?**	**How helpful were the files in preparing for quizzes?**	**How helpful were the files in writing your lab reports?**
Standard Deviation	0.87	0.97	1.06	1.08
Mean	3.85	3.43	3.04	3.04
Statistically significantly different from neutral? (Wilcoxon signed rank test)	Y	Y	N	N